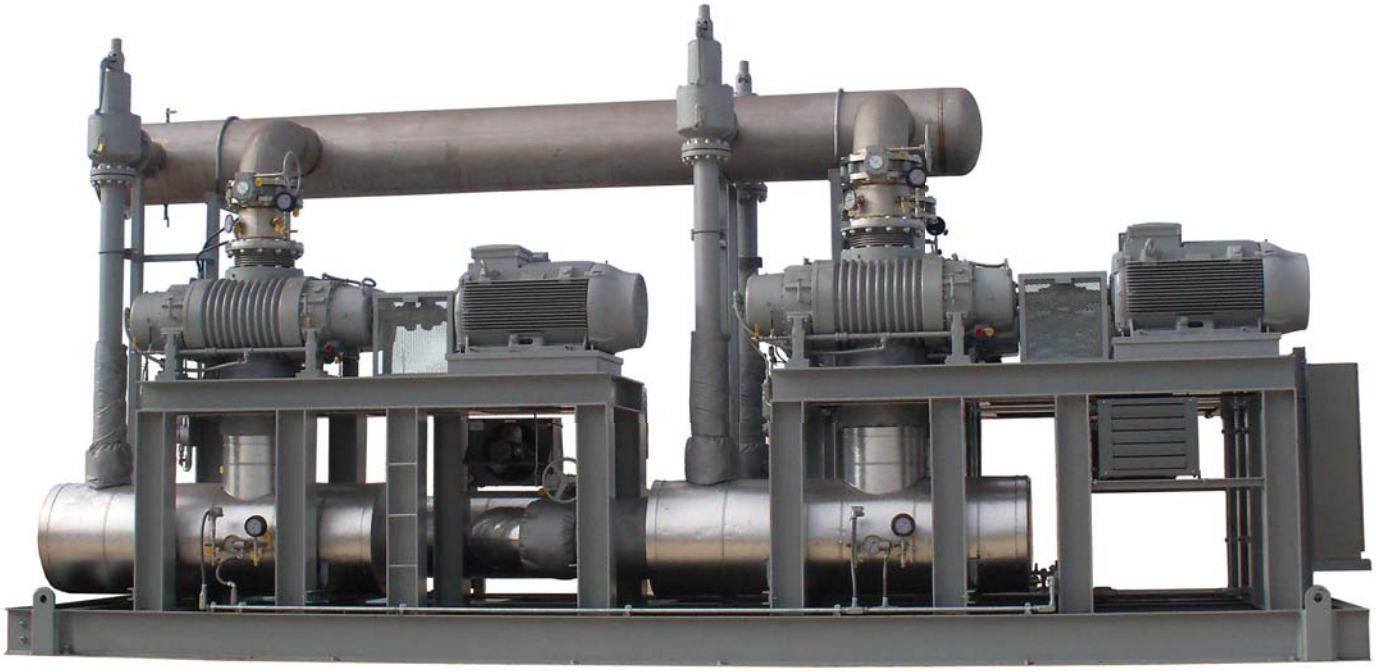
# Blower Package

## Installation, operation & maintenance manual



Vilter™

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Climate Technologies

# Blower Packages - Standard Vilter Warranty Statement

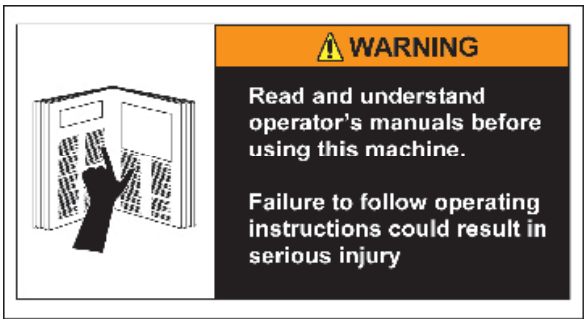
Seller warrants all new assembled equipment manufactured by it and supplied to Buyer to be free from defects in materials and workmanship for a period of (a) eighteen (18) months from the date of shipment or (b) twelve (12) months from the date of installation at the end user's location, whichever occurs first.

If within such period any such product shall be proved to Seller's satisfaction to be defective, such product shall be repaired or replaced at Seller's option. Such repair or replacement shall be Seller's sole obligation and Buyer's exclusive remedy hereunder and shall be conditioned upon (a) Seller's receiving written notice of any alleged defect within ten (10) days after its discovery, (b) payment in full of all amounts owed by Buyer to Seller and (c) at Seller's option, Buyer shall have delivered such products to Seller, all expenses prepaid to its factory. Expenses incurred by Buyer in repairing or replacing any defective product (including, without limitation, labor, lost refrigerant or gas and freight costs) will not be allowed except by written permission of Seller. Further, Seller shall not be liable for any other direct, indirect, consequential, incidental, or special damages arising out of a breach of warranty.

This warranty is only applicable to products properly maintained and used according to Seller's instructions. This warranty does not apply (i) to ordinary wear and tear, damage caused by corrosion, misuse, overloading, neglect, improper use or operation (including, without limitation, operation beyond rated capacity), substitution of parts not approved by Seller, accident or alteration, as determined by Seller or (ii) if the product is operated on a gas with an H2S level not approved by Seller. In addition, Seller does not warrant that any equipment and features meet the requirements of any local, state or federal laws or regulations. Products supplied by Seller hereunder which are manufactured by someone else are not warranted by Seller in any way, but Seller agrees to assign to Buyer any warranty rights in such products that Seller may have from the original manufacturer. Labor and expenses for repair are not covered by warranty.

THE WARRANTY CONTAINED HEREIN IS EXCLUSIVE AND IN LIEU OF ALL OTHER REPRESENTATIONS AND WARRANTIES, EXPRESS OR IMPLIED, AND SELLER EXPRESSLY DISCLAIMS AND EXCLUDES ANY IMPLIED WARRANTY OF MERCHANTABILITY OR IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.

Any description of the products, whether in writing or made orally by Seller or Seller's agents, specifications, samples, models, bulletins, drawings, diagrams, engineering sheets or similar materials used in connection with Buyer's order are for the sole purpose of identifying the products and shall not be construed as an express warranty. Any suggestions by Seller or Seller's agents regarding use, application or suitability of the products shall not be construed as an express warranty unless confirmed to be such in writing by Seller.




**READ CAREFULLY BEFORE INSTALLING AND STARTING YOUR BLOWER.**

The following instructions have been prepared to assist in installation, operation and maintenance of Vilter blower packages. Following these instructions will result in a long life of the package with satisfactory operation.

The entire manual should be reviewed before attempting to install, operate, service or repair any part of the package.

**A blower is a positive displacement machine. It is designed to compress gas. The blower must not be subjected to liquid carry over. Care must be exercised in properly designing and maintaining the system to prevent conditions that could lead to liquid carry over. Vilter Manufacturing is not responsible for the system or the controls needed to prevent liquid carry over and as such Vilter Manufacturing cannot warrant equipment damaged by improperly protected or operating systems.**

**Vilter components are thoroughly inspected at the factory. However, damage can occur in shipment. For this reason, the equipment should be thoroughly inspected upon arrival. Any damage noted should be reported immediately to the Transportation Company. This way, an authorized agent can examine the unit, determine the extent of damage and take necessary steps to rectify the claim with no serious or costly delays. At the same time, the local Vilter representative or the home office should be notified of any claim made.**

All inquires should include the Vilter sales order number, serial and model number. These can be found on the nameplate on the blower.

All requests for information, services or parts should be directed to:

**Vilter Manufacturing LLC**
Customer Service Department
P.O. Box 8904
5555 South Packard Ave
Cudahy, WI 53110-8904 USA
Telephone: 1-414-744-0111
Fax:1-414-744-3483
E-mail: info.vilter@emerson.com

Equipment Identification Numbers:

Vilter Order Number: _____Blower Serial Number: _____
Vilter Order Number: _____Blower Serial Number: _____
Vilter Order Number: _____Blower Serial Number: _____
Vilter Order Number: _____Blower Serial Number: _____

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## How To Use This Manual

This manual contains instructions for blower packages. It has been divided into six sections:

Section 1: General Information

Section 2: Theory of Operation

Section 3: Installation

Section 4: Operation

Section 5: Maintenance & Service

Appendices

It is highly recommended that the manual be reviewed prior to servicing system parts.

Figures and tables are included to illustrate key concepts.

Safety precautions are shown throughout the manual. They are defined as the following:

NOTICE - Notice statements are shown when there are important information that shall be followed. Not following such notices may result in void of warranty, serious fines, serious injury and/or death.

WARNING - Warning statements are shown when there are hazardous situations, if not avoided, will result in serious injury and/or death.

CAUTION - Caution statements are shown when there are potentially hazardous situations, if not avoided, will result in damage to equipment.

NOTE - Notes are shown when there are additional information pertaining to the instructions explained.

### ADDITIONAL IMPORTANT NOTES

- Due to continuing changes and unit updates, always refer to the Vilter.com website to make sure you have the latest manual.
- Any suggestions of manual improvements can be made to Vilter Manufacturing at the contact information on page ii.

## Blower Package Component Identification

Each blower package may differ, but below are typical components that can be found on each package.

For specific components on the blower (such as the oil filter, oil pressure gauge, oil sight glass, oil cooler, oil pump, drain plug and connections), refer to Blower Manual in Appendices.

1 - Box Beam Base
2 - Blower
3 - Intake Expansion Joint
4 - Intake Silencer
5 - Motor
6 - Coupling Guard
7 - Discharge Silencer
8 - Drain Plug
9 - Intake Filter/Silencer
10 - Enclosure
11 - Belt Guard
12 - Pressure Safety Relief Valve
13 - Coupling
14 - Control Panel
15 - Junction Box
16 - Suction Line

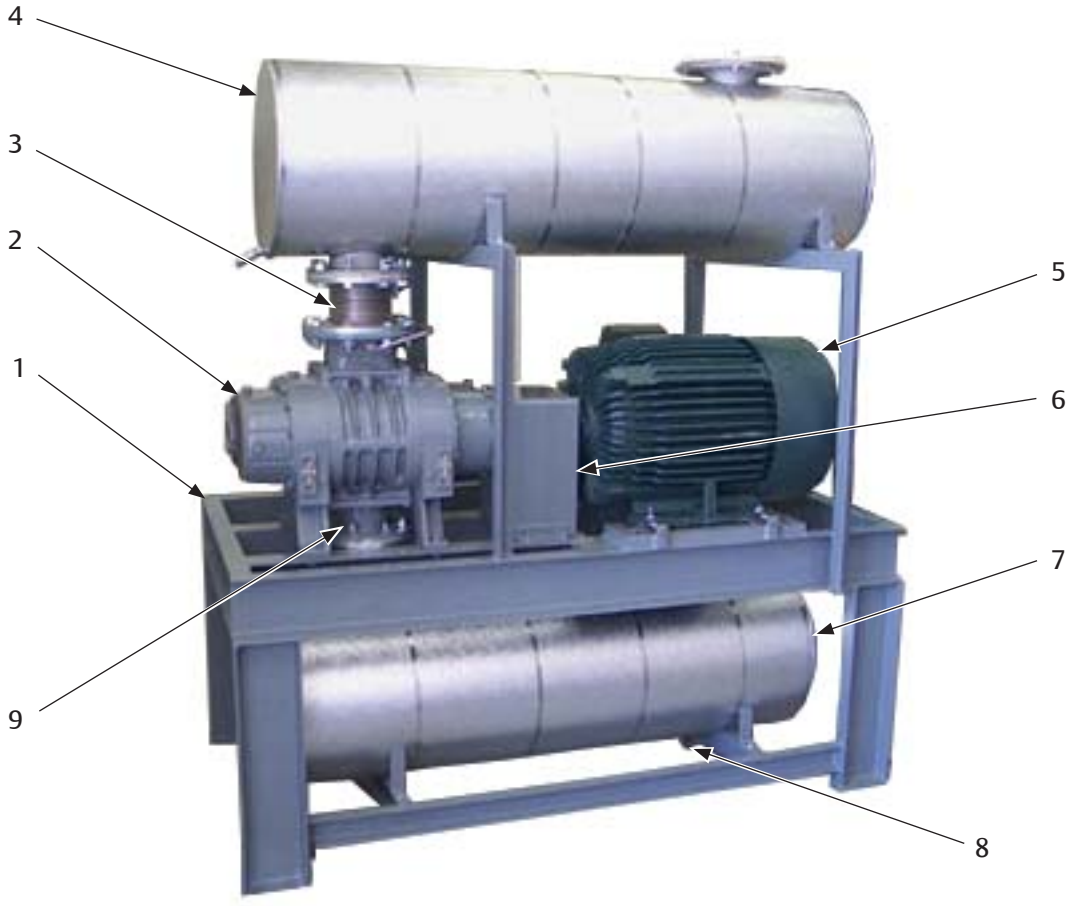



**Figure 1-1. Single Blower Package Components (Direct Drive)**

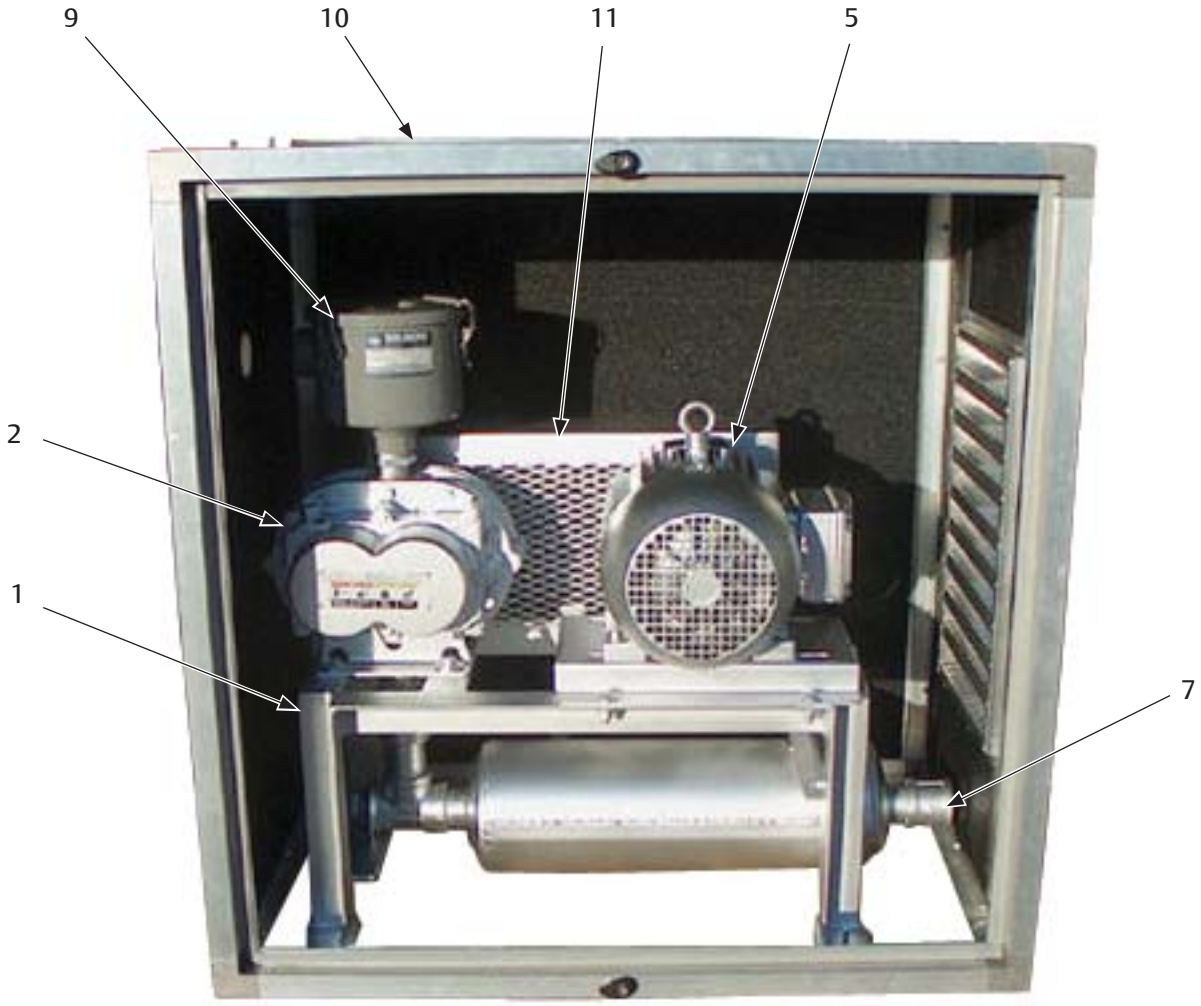



**Figure 1-2. Single Blower Package Components (Belt Driven)**

1 - Box Beam Base
2 - Blower
3 - Intake Expansion Joint
4 - Intake Silencer
5 - Motor
6 - Coupling Guard
7 - Discharge Silencer
8 - Drain Plug
9 - Intake Filter/Silencer
10 - Enclosure
11 - Belt Guard
12 - Pressure Safety Relief Valve
13 - Coupling
14 - Control Panel
15 - Oil Cooler (Air Cooled)
16 - Suction Line

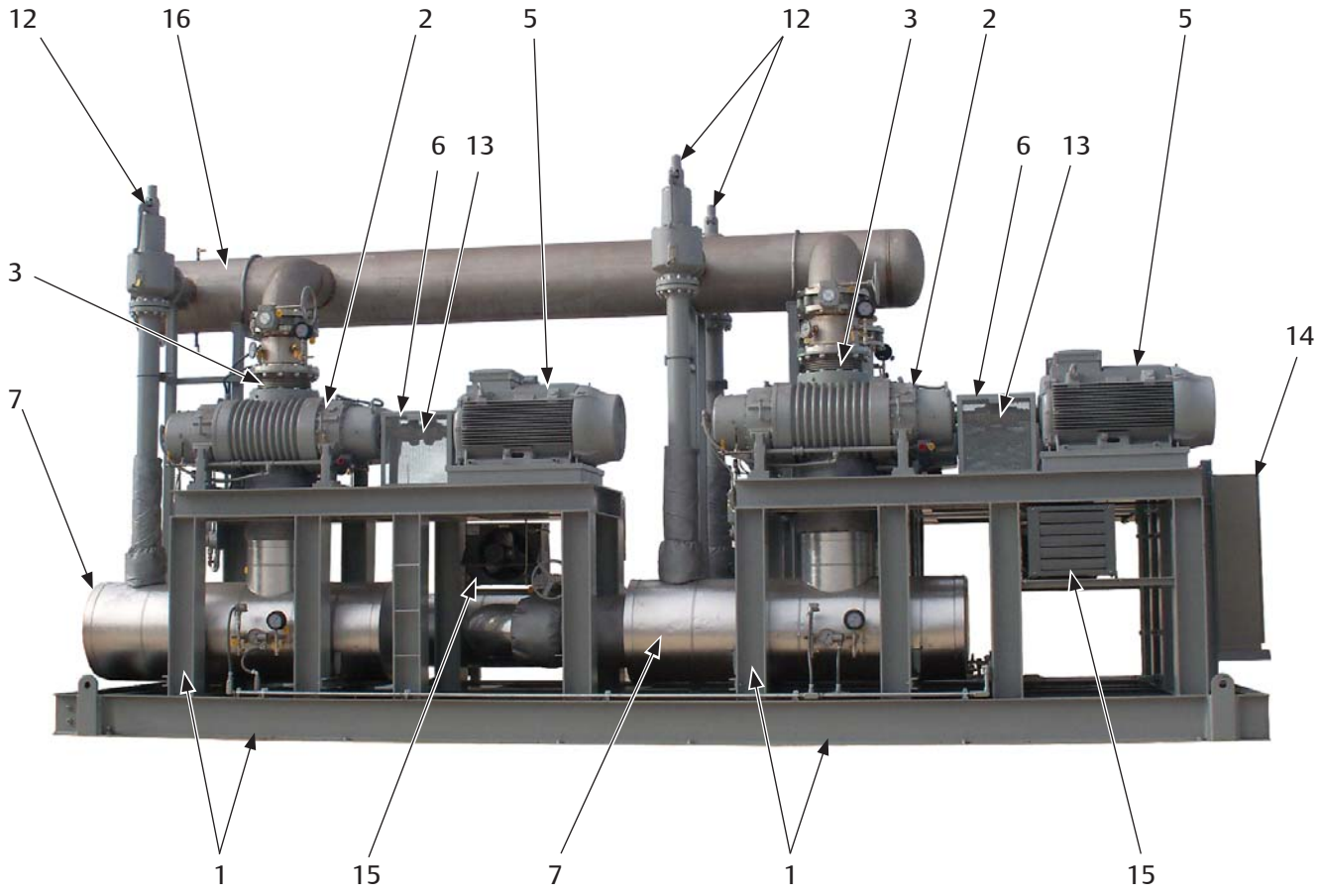



**Figure 1-3. Custom Blower Package Components (Multiple Blowers - Direct Drive)**

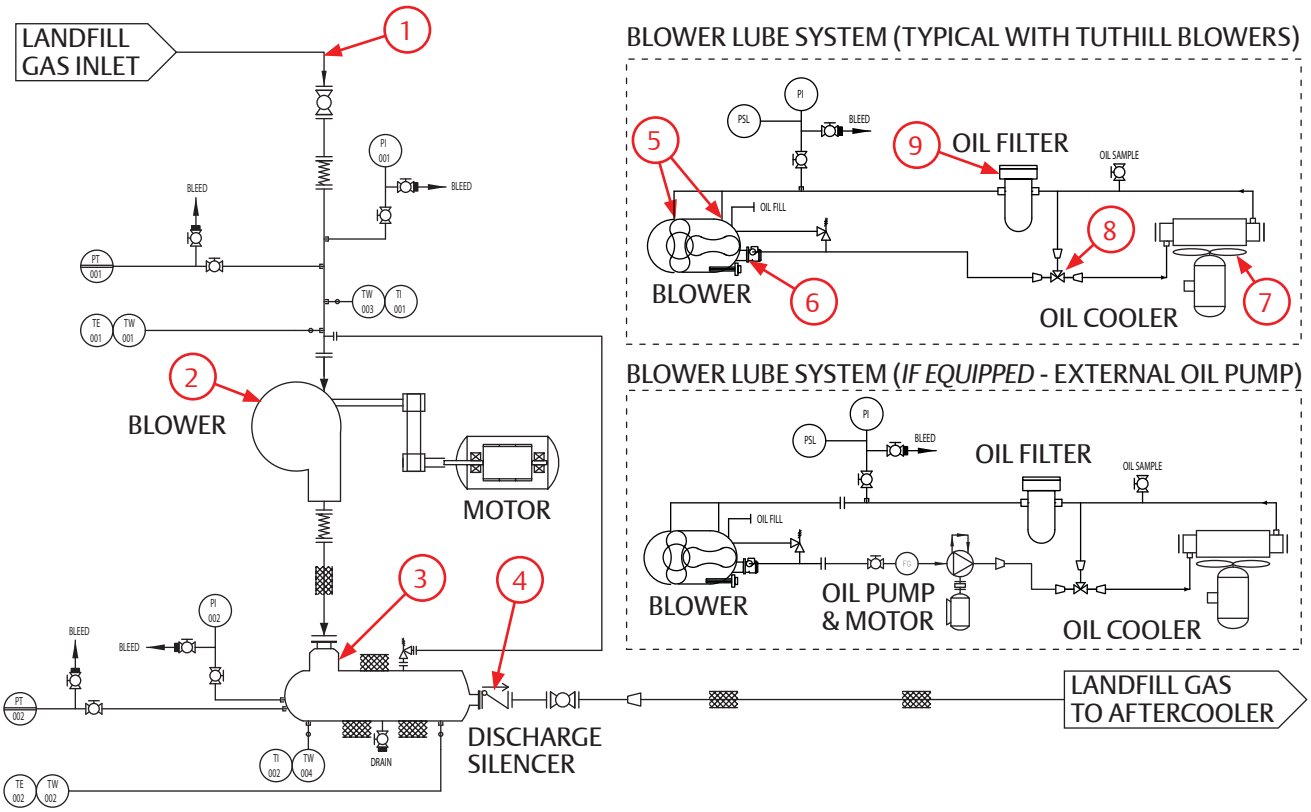



**Figure 2-1. Blower Package Piping & Instrumentation Diagram (P&ID)**

## Gas Flow

The gas compression process begins as gas enters the inlet line (1) to the blower (2). The gas is then pressurized through the blower and discharged as high pressure gas into the discharge silencer (3). From the discharge silencer the gas is then pushed out to an aftercooler for cooling.

A check valve (4) is also installed after the discharge silencer. The check valve does not allow gas to return through the blower system during shutdown periods.

## Oil Flow

Oil in the blower package serves as lubrication for the two bearings (5) located on either end of the blower (2). Lubrication can be provided by internal shaft driven, external oil pump or splash feed. The pump lube system (6) pumps oil from the blower to the air cooled oil cooler(7) for cooling. A temperature control valve (8) controls the oil temperature by allowing oil bypass. As oil flows from the oil cooler or temperature control valve, the oil is filtered through a filter (9) and flows back towards the bearings on the blower.

This is a continuous cycle.

## Control System

If supplied with a Programmable Logic Controller (PLC), the blower package can be controlled by the control panel. The main function of the control panel is to control the blower system from the data that it receives from the sensors around the package.

## Temperature & Pressure Instruments

Temperature elements/indicators and pressure transmitters/indicators are instruments used to measure temperatures and pressures at specific locations on the blower package. Temperature elements and indicators can be identified by TE and TI. Pressure transmitters and indicators can be identified by PT and PI.

## Delivery Inspection

All equipment supplied by Vilter are thoroughly inspected at the factory. However, damage can occur in shipment. For this reason, the units should be thoroughly inspected upon arrival, prior to off-loading. Any damage noted should be photographed and reported immediately to the transportation company. This way, an authorized agent can examine the unit, determine the extent of damage and take necessary steps to rectify the claim with no serious or costly delays. At the same time, the local Vilter representative or the home office should be notified of any claims made within ten (10) days after its discovery. Refer to long term storage for additional recommendations.

## Rigging and Lifting

# WARNING

**When rigging and lifting a blower package, use proper lifting device capable of lifting and maneuvering the weight and size of the blower package. Use only qualified personnel, additional personnel and lifting equipment (i.e. spreader bar) as required. Failure to comply may result in death, serious injury and/or damage to equipment.**

Only qualified personnel shall operate rigging and lifting equipment. Ensure that the lifting device is capable of lifting the weight of the blower package. Refer to supplied General Assembly (GA) drawing for package center of gravity.

There are a few points to consider prior to moving the unit:

- Ensure that the weight is evenly distributed amongst the lifting device (i.e. lifting chains/straps and spreader bar) prior to lifting.
- Ensure that the lifting device is not obstructed by any part of the package to prevent any unnecessary damages.
- Use additional personnel as needed to spot and aid in maneuvering the package.
- Ensure there is plenty of space to maneuver the package and a clear path to its location.
- Use lifting points located on the package base.

*Use lifting chains/straps and spreader bars. Evenly distribute weight. Keep lifting chains/straps and spreader bar clear of components to prevent damage.*

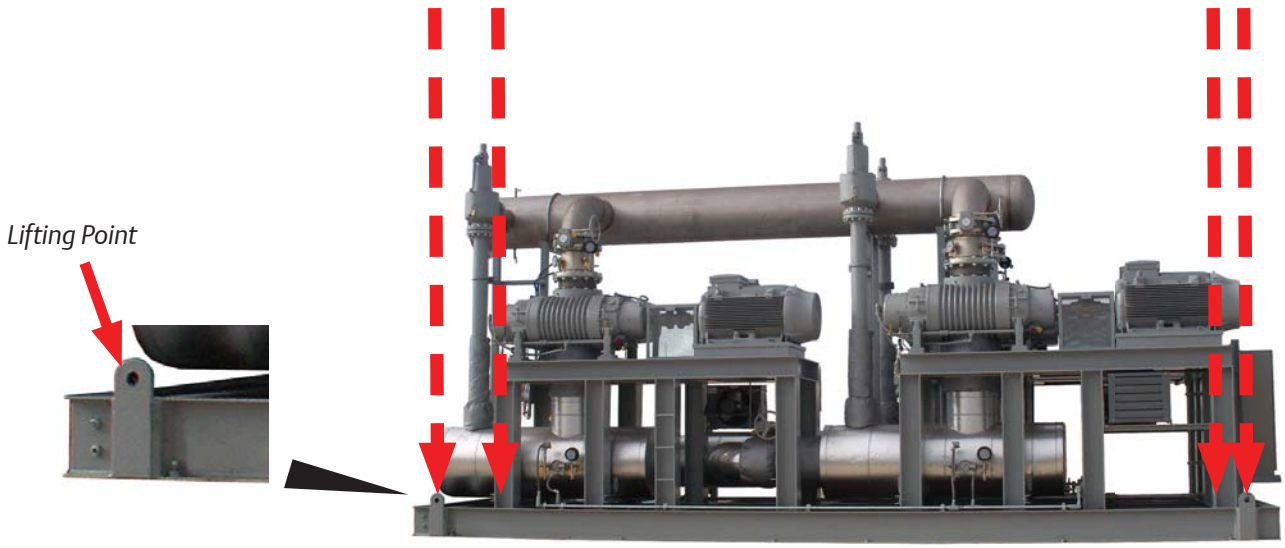



**Figure 3-1. Rigging and Lifting**

## Long Term Storage Recommendations

The procedure described is a general recommendation for long term storage (over one month of no operation). It is the responsibility of the installation firm and end user to address any unusual conditions. Warranty of the system remains in effect as described at the beginning of this manual, section page i.

### BLOWER PACKAGE STORAGE

- In case the equipment is not to be installed immediately, store it in a clean, dry, constant temperature location. Keep covers and plugs on openings. Connect all furnished space heaters on electric motors.
- When outdoor storage is necessary, all equipment must be adequately covered with tarps and stored on a level surface above ground level. Be sure all openings are completely sealed.
- To ensure that the equipment is properly protected and without any sign of rust or corrosion, inspect it at least every four weeks if stored indoors, or every two weeks if stored outdoors. Any discrepancy must be immediately corrected. If equipment is to be stored for longer than 90 days, contact Vilter for recommendations.
- For additional long term storage recommendations for blowers, see Appendices.

### CONTROL EQUIPMENT STORAGE

- If the control equipment cannot be installed and operated without delay, proper precautions shall be taken to prevent damage due to corrosive atmospheres, humidity, dirt, dust and physical blows.
- The equipment must be stored in a clean, dry, rodent-free location and maintained at or above ambient temperature. The shipping enclosure is to be left on and covered with a plastic film or similar covering to keep out dust, dirt, water, and foreign substances. Desiccant bags must be installed under plastic to prevent condensation build up.
- If panel space heaters are provided, they must be connected and kept energized at all times. If no panel space heaters are provided and the panel is subject to dampness which could cause condensation, supplemental heaters must be used to maintain the equipment at a temperature above the dew point.
- Equipment damage due to corrosion, wetness, dust, dirt, or abuse after receipt at original destination is not covered under warranty and corrections for these problems shall be at customer's expense.

### MOTOR STORAGE

The following are general recommendations. Refer to specific motor manufacturer instructions for storage recommendations.

- Cover the motor completely to exclude dirt, dust, moisture, and other foreign materials.
- If the motor can be moved, it is suggested that the entire motor be encased in a strong, transparent plastic bag. Before sealing this bag, a moisture indicator should be attached to the side of the motor and several bags of silica-gel desiccant be placed inside the bag around the motor. When the moisture indicator shows that the desiccant has lost its effectiveness, as by a change in color, replace desiccants.
- If equipped, space heaters must be installed to keep the motor at least 10°F above the ambient temperature.
- Add grease every 3 months.
- Cover all bare metal surfaces with rust inhibitor.
- Manually rotate motor shaft several revolutions (approximately 6) every 3 months to prevent flat spots on the bearing surfaces.

## Foundation

The following information is provided to assist the customer in planning the installation prior to the shipment of equipment. Consult professionals, such as building inspectors, structural engineers, geotechnical engineers and/or construction contractors prior to starting.

### GENERAL DESIGN

**NOTICE**

Do not prepare installation site based on a non-certified drawing.

1. Foundation design depends on local soil conditions and several other factors, and can only be discussed generally here. For satisfactory operation of supported equipment, a concrete foundation must be rigid, must have minimum deflections, and must be free from resonant frequencies in the operating speed ranges of the equipment. A helpful reference is the “Compressed Air and Gas Handbook”, latest edition, published by The Compressed Air and Gas Institute, New York City, see Appendices. Blower, gear unit, driver, etc, must not be directly mounted on the foundation. Soleplates or baseplates must be provided. Check General Assembly drawing for specific foundation requirements.

2. Length and width dimensions of the foundation should provide at least 6 inches (15 cm) from any edge to the nearest machine anchor bolt, as located from the certified manufacturer’s general arrangement drawing. Depth dimensions should be determined by design, but the mass of foundation should be at least 1-1/2 time the total weight of the assembled blower and driver. The concrete block should be permitted to cure for a minimum of 28 days before the blower is grouted in place. Any block distorted during curing will then have little or no effect on equipment and alignment. To simplify machine leveling and provide a good grouting bond, the top of the foundation should be struck-off as level as possible, but left with a rough surface.

3. Prior to installing units, the top of the foundation should be thoroughly cleaned. All loose debris and dirt should be removed and the anchor bolt sleeves cleaned out. Any oil or grease on the foundation will impair the bonding of the grout and must be removed with a strong, hot detergent or caustic solution. Glazed concrete surfaces should be roughened by chipping.

## Anchor Bolts

### ADHESIVE CAPSULE ANCHOR BOLTS

- The use of adhesive capsule anchor bolts are recommended, they are a much more convenient system for anchoring. Baseplates are specifically designed to allow for easy installation of this type of anchor. Their use eliminates the time consuming an expensive method of installing conventional anchor bolts.
- The baseplate should be set in the desired location, and the holes drilled for the adhesive capsule anchor bolts directly through the baseplate anchor bolt holes.
- Anchor bolt size should be selected from Table 3-1.
- Installation of the anchor bolts is shown in the literature accompanying the anchors. Although these instructions may vary slightly from one manufacturer to another, the basic steps as shown, are common to all, see Figure 3-2.

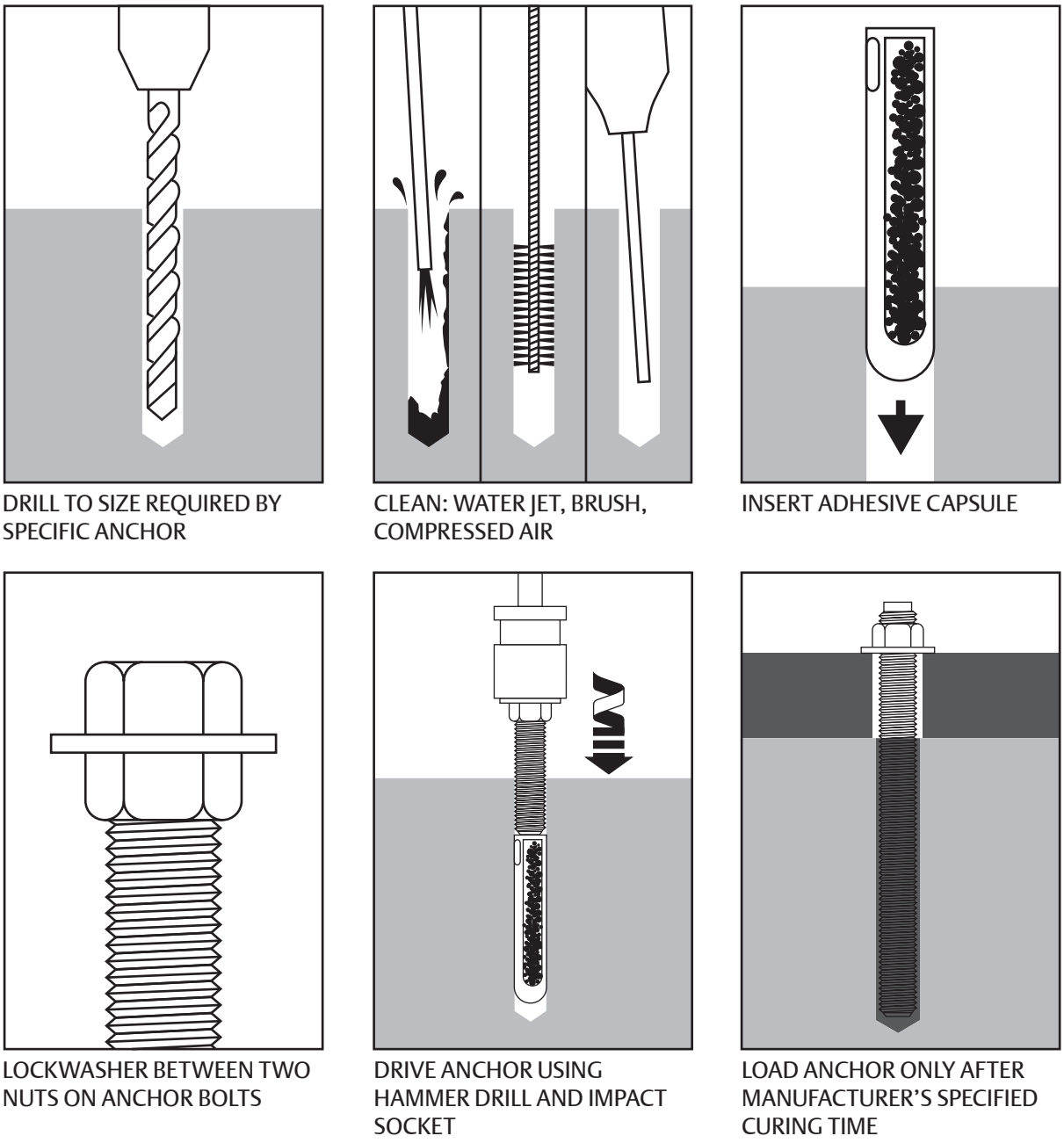



**Figure 3-2. Adhesive Anchor Bolts**

## Table 3-1. Recommended Anchor Bolt Sizes

| Unit Gear Size | Soleplates | | | | Baseplates | | | |
|---|---|---|---|---|---|---|---|---|
| | Bolt | | Sleeve | | Bolt | | Sleeve | |
| | Diameter | Length | Diameter | Length | Diameter | Length | Diameter | Length |
| 8” | 7/8” | 18” | 2-1/2” | 12” | 3/4” | 18” | 2-1/2” | 12” |
| 10” | 1” | 25” | 3” | 18” | 3/4” | 18” | 2-1/2” | 12” |
| 11” | 1” | 25” | 3” | 18” | 3/4” | 18” | 2-1/2” | 12” |
| 12” | 1-1/8” | 25” | 3” | 18” | 3/4” | 18” | 2-1/2” | 12” |
| 14” | 1-1/8” | 25” | 3” | 18” | 1” | 18” | 3” | 18” |
| 16” | 1-1/8” | 25” | 3” | 18” | 1” | 25” | 3” | 18” |
| 18” | 1-1/4” | 25” | 3” | 18” | 1” | 25” | 3” | 18” |
| 20” | 1-1/4” | 25” | 3” | 18” | 1” | 25” | 3” | 18” |

### CONVENTIONAL ANCHOR BOLTS

- Anchor bolts are to be placed within the foundation forms before concrete is poured. Bolts and pipe sleeves should be as shown in Figure 3-3.

**NOTE**

Alternate commercially available pre-fabricated anchor bolt assemblies are acceptable provided anchor bolt sizes are per Table 3-1. Sleeve diameter and length may vary slightly from Table 3-1 when using commercially available pre-fabricated anchor bolt assembly. For standard supplied (Pre-fabricated) anchor bolt assembly, see Figure 3-4. For dimensions, see General Arrangement Drawing for referenced drawing number of Air & Gas Systems supplied pre-fabricated anchor bolt assembly.

- Carefully constructed templates are required to hold anchor bolts and sleeves within the necessary tolerance while placing concrete in the foundation. These templates are usually made of wood and secured to the foundation forms. Anchor bolts shall be set to the dimensions specified on the certified general arrangement drawing within a tolerance of 1/8” (3 mm), by locating and drilling the holes in the template after they have been secured to braced forms.
- The template must be rigid enough to prevent bolts from shifting while the concrete is being poured. After the concrete has been poured, but before it has hardened, it is advisable to re-check the position of the anchor bolts. Concrete should be kept out of the sleeves during pouring of the foundation. When using a template, this can be accomplished by pulling the upper end of the sleeves tight against the under side of the template before pouring concrete. This will allow the bolts enough freedom to be moved to correct for small variations in bolt setting and machine or baseplate drilling.
- Bolt position should be adjusted vertically so that the top ends will extend at least 1-1/2” x diameter above the top of the soleplate or of the baseplate flange, or as shown on the certified General Arrangement (GA) drawing. The pipe sleeves are to be filled during grouting operation. Refer to the chart below for anchor bolt and sleeve dimensions, or GA drawing if anchor bolt assemblies are supplied.
- A steel plate approximately ½” thick and of ample area should be used under the leveling screws (if not provided), see Figure 3-3.

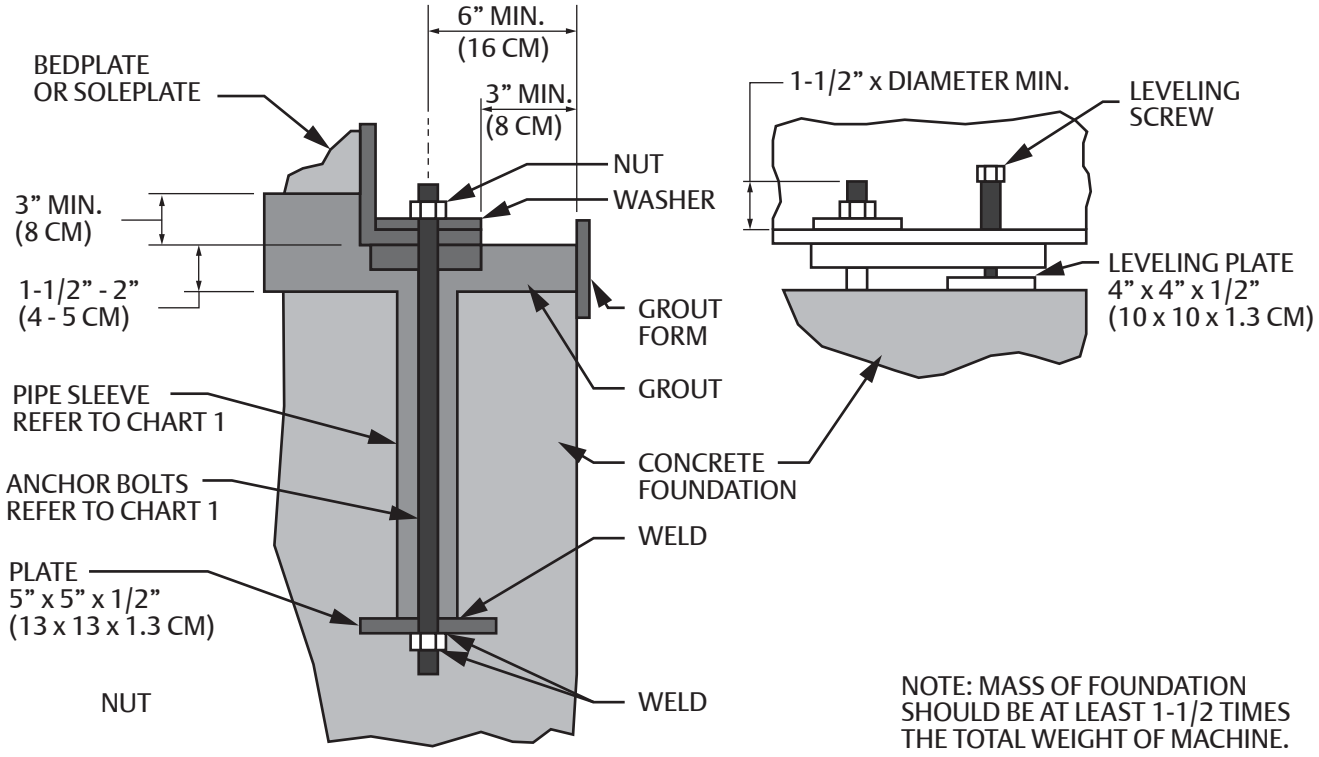



**Figure 3-3. Conventional Anchor Bolts**

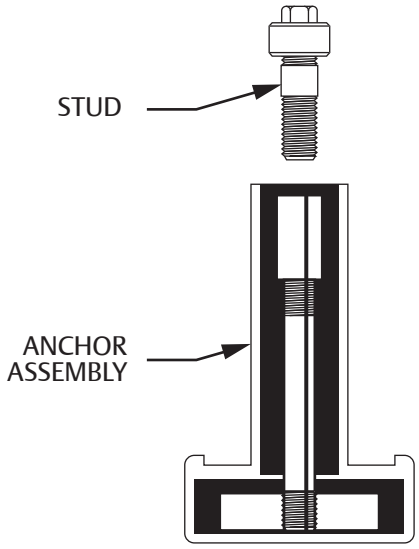



**Figure 3-4. Standard Supplied Anchor Bolt Assembly**

## Grouting

- Longitudinal and transverse base beams and rib members should be continuously supported by grout. This usually requires grouting the entire area under baseplates to a minimum height of 3" above the bottom of baseplate.
- No piping is to be assembled to the equipment nor foundation bolts tightened until grouting is completed and cured.
- Tabletop bases should have grout poured to the top of the anchor bolt pads as shown in Figure 3-5.
- Anchor bolt arrangement and installation for acoustic enclosure is to be of the same design as baseplate anchor arrangement. Refer to chart for corresponding anchor assembly of anchor bolt diameter.
- Non-shrink cement-based or epoxy grouts shall be used. Sand-cement dry pack is not recommended. Epoxy type grout is recommended since it is impervious to oils and chemicals, it bonds well to the concrete foundation and baseplates, and it has greater strength than cement-based grouts.
- Follow grout manufacturer's instructions.

SOME SOURCES OF GROUT

<u>Epoxy Type Grouts</u>

Ceilcote #648

- The Ceilcote Company
  Berea, OH
  (216) 243-0700
- Five Start Epoxy Grout
  Riverside, CT
  (203) 336-7900

<u>Cement-Based Grouts</u>

Embeco 636

- Master Builders
  Cleveland, OH
  (216) 831-5500
- U.S. Grout Corporation
  Riverside, CT
  (203) 336-7900

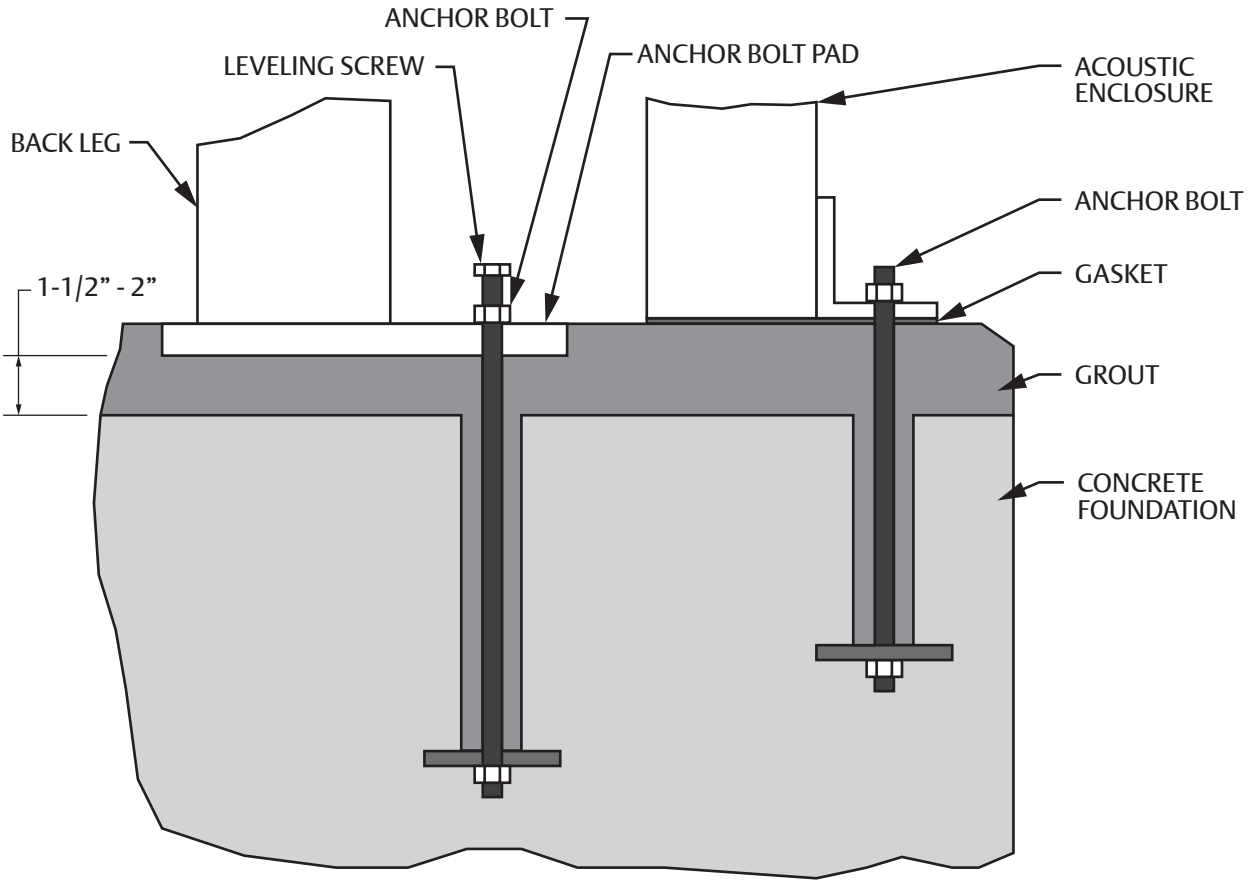



**Figure 3-5. Tabletop Bases and Grouting**

## Process Gas or Air Piping

1. The following precautions and/or considerations shall be observed in the design of customer or user supplied piping systems connecting to the machine. Vilter is not responsible for customer or user supplied piping. For maximum allowable flange loads, see Figure 3-6.

   • Consideration must be given to thermal expansion as well as reaction loads from pressurization, and sufficient anchors, expansion joints, expansion loops, or bends are to be provided so that piping strains on equipment will be eliminated. The installation of a spool-type flexible expansion joint or coupling near the equipment connections is recommended. Discharge expansion joint for pressure service or inlet expansion joint if vacuum service shall be equipped with control rods which are installed with the nuts finger-tight, then secured by locknuts.

   • All supports for piping shall be furnished by the customer and shall be located as near as possible to equipment connections.

   • The inlet and discharge piping shall be arranged to provide a smooth flow with the uniform gas velocity over the entire flange area. Elbows shall be of the long radius type.

   • The use of inlet and discharge silencers to reduce noise and pulsations shall be used. Generally, they must be mounted next to the blower flange with an expansion joint between. If this is not possible, they must be located not more than one pipe diameter away from the blower's inlet and discharge flanges, to minimize generation of harmful pressure pulsations. Pressure pulsations increase dynamic loading on the machine, the drive train, and the piping system. Piping resonant pressure pulsations on the machines' inlet or discharge cannot be permitted.

   • Rotary positive blowers produce four pulsations per revolution of drive shaft. Spiraxial compressors produce one pulsation per revolution.

2. At initial operation, install a temporary corrosion resistant screen at the blower inlet connection. The screen shall be made of 16 mesh (.020" diameter) wire backed with 3 mesh wire clothe (1/4" hardware cloth) for strength and should be securely installed at the inlet flange of the blower. Backing cloth wire shall be a minimum of 0.047" diameter for 8" pipe, 0.063" diameter for 12" pipe, 0.080" diameter for 16" pipe, 0.105" diameter for 20" pipe, and 0.120" diameter for 24" pipe. A manometer connected to read pressure drop across the screen will indicate when it needs cleaning. Do not allow pressure drop to exceed 55 inches water. Clean and replace the screen until debris no longer appears. Do not leave it installed permanently, as the wire will eventually deteriorate and pieces may go into the blower causing serious damage. (Typically, screens are installed for 1-2 days of operation.).

3. Piping should be sized so that the gas velocity in the line does not exceed 100 feet per second (30 m/s). The use of inlet or discharge piping smaller than the blower flange opening is not allowed. (Smaller pipes act as restrictions and result in high pipe losses with possible compressor or driver overloads.)

4. A relief valve between any shutoff valve and unit connection is mandatory.

5. Equipment flange connection centerline dimensions, as shown on the general arrangement, will have a tolerance of ±1/4".

### INSULATION

Various lines (discharge piping, interstage piping, etc), and parts of equipment may become extremely hot during use. It is therefore required to properly insulate hot surfaces for prevention of accidents and injury due to contact with these surfaces. Unless otherwise specified, the customer shall supply and install all insulation required for personnel safety.

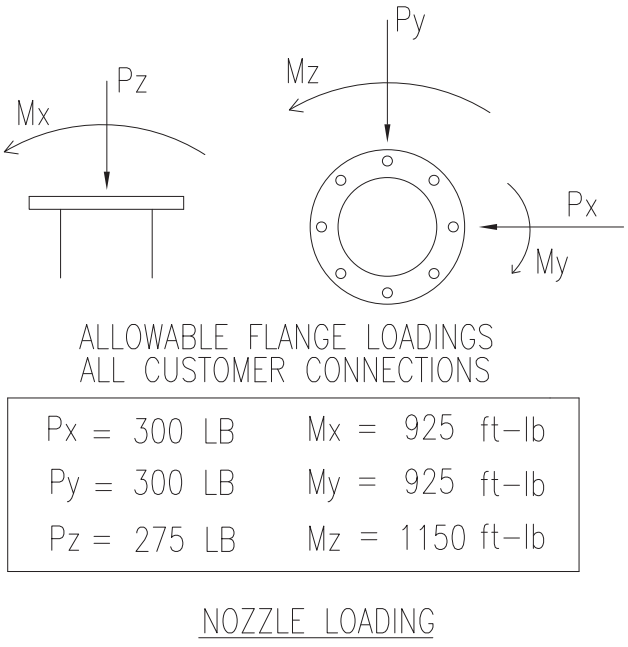



**Figure 3-6. Flange Loads**

## Motors

For additional motor installation instructions, refer to specific motor manufacturer instructions manual.

### MOTOR RE-ENERGIZATION

Motors are inherently capable of developing transient torques considerably in excess of their rated torques when exposed to out-of-phase bus transfer or momentary voltage interruption and re-closing on the same bus. The magnitudes of these transient torques range from approximately two to twenty times rated torque as a function of the motor, operating conditions, switching times, system inertia, etc.

To eliminate the possibility of damaging the motor, driven equipment, or other items, it is recommended that the power supply system be designed so that motor re-energization cannot occur while the motor is rotating. Also, any power interruption due to bus transfer, instrumentation problems, or any other reason, should cause the motor to shut down. The motor must be allowed to coast to a complete stop prior to re-energization. Generally, reclosure shall not be allowed during the time period between six cycles and 1-1/2 times constants for the motor and power factor correction (if any) combined. A specific review of equipment should be made to determine allowable reclosure periods.

### MOTOR LOCK ROTOR TORQUE

Certain motors are capable of developing a high shock torque at start-up which may cause blower damage due to gear slippage. Therefore, when specifying motor characteristics, lock rotor torque must not exceed the percent of full load motor torque, see Table 3-2 for maximum motor sizes.

**NOTE**

When a smaller than maximum motor size is specified, the maximum motor size should meet the maximum operating conditions. Refer to Figure 3-7 for typical speed torque characteristics.

## Vibration

For additional information on mechanical vibration,see Appendices.

### DRIVE TRAIN SYSTEM TORSIONAL VIBRATIONS

Harmful drivetrain system torsional natural frequencies must be outside of the allowed operating speed range. If all the equipment are supplied within the drivetrain, all equipment will be properly sized to prevent any harmful natural torsional frequencies occurring within the operating speed range.

Table 3-2. Motor Sizes

| GD-IN | Maximum Motor Size |
|---|---|
| 10 (22 PSL) | 300 HP |
| 12 (22 PSL) | 400 HP |
| 14 (22 PSL) | 600 HP |
| 16 (22 PSL) | 800 HP |
| 18 (22 PSL) | 900 HP |
| 20 (22 PSL) | 1250 HP |
| 20 (22 PSL) | 1500 HP |

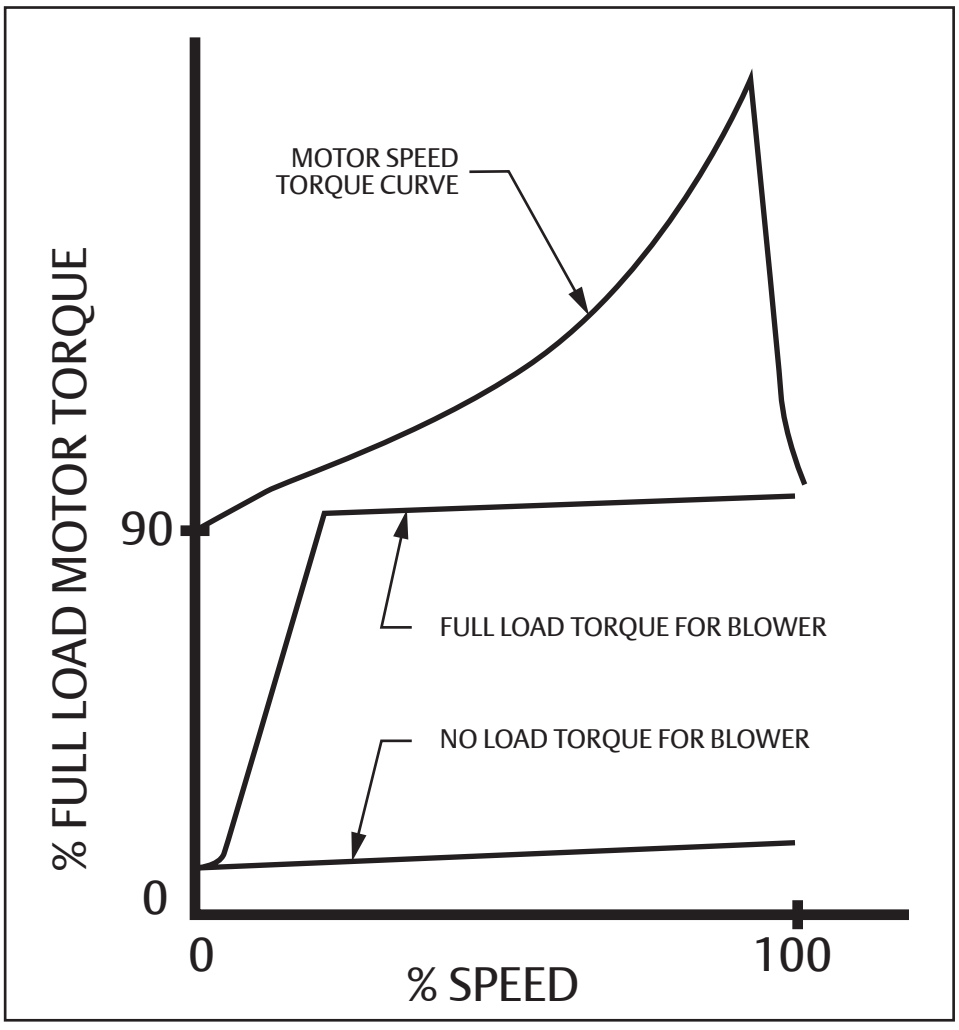



Figure 3-7. Speed Torque Characteristics

## Blowers and Extended Shutdown Periods

For blower operating instructions and for information relating to extended shutdown periods, refer to:

- Appendix A - Tuthill PD Plus Rotary Positive Displacement Blower Installation, Operation, Maintenance and Repair Manual
- Appendix B - Tuthill Blower Long Term Storage Procedures
- Appendix C - Tuthill Technical Bulletin #25, Instructions for Injecting Fuel Oil, Kerosene and Lube Oil Into Blowers Handling Sewage Gas
- Appendix D - Tuthill Technical Bulletin #4, Recommended Lubricants for Tuthill M-D Pneumatics Rotary Blowers and Vacuum Boosters
- Appendix E - Gardner Denver Parts List, Operating and Service Manual, Blowers/Vacuum Pumps, 11CP-P Series

For evaluating mechanical vibration, refer to:

- Appendix F - Compressed Air and Gas Institute - Mechanical Vibration

## Motors

For motor installation, operation and maintenance instructions, refer to specific motor manufacturer instructions manual.

## Pre Start-Up Checklist

Name (Please Print):_____ Signature:_____

Company:_____ Vilter Sales Order Number:_____

Equipment Description:_____ Date (M/D/Y):_____

☐ 1. Inspect package for any loose wires or capillary tubing to and from the safety shutdown switches. Tighten any loose bolts.

☐ 2. Remove drive guard. For V-belt drive, check for proper belt tension and sheave alignment per V-belt drive instructions. Use V-belt tension test tool for this procedure. For coupling drive units, check final alignment conformance to coupling manufacturer's recommendations.

☐ 3. If splash lubricated, check the oil level on each end of the blower. For two-stage blowers, check both blowers. Fill to proper level as indicated on sight gauge using oil viscosity as shown in blower manufacturer instruction manual. DO NOT OVERFILL. If pressure lubricated, the oil reservoir has no oil in it. It must be filled to proper level prior to starting.

☐ 4. Rotate blower by hand and check for any obstruction or unusual noise. NOTE: Blower packages are shipped without oil.

☐ 5. Make sure motor is wired properly.

☐ 6. "Bump Start" control button to check for proper rotation.

☐ 7. If equipped with external oil pump, check for correct rotation.

☐ 8. Be sure pressure is off of system downstream and/or upstream of the blower. Make sure all blind flanges are removed from piping and that no restriction is in upstream or downstream side of the blower.

☐ 9. Make sure electrical overload devices are installed in the motor control center. Check all shutdown circuitry for proper wiring logic. Check all shutdown and alarm switches for proper set points.

☐ 10. Check inlet filter for any dirt or obstructions.

☐ 11. Open any drains in silencers, blowers or coolers. Replace plugs after draining.

☐ 12. Replace drive guard before starting.

## Start-Up

The following check list is to help verify and check equipment prior to start-up.

☐ 1. For pressure lubricated units, if supplied with water-cooled oil cooler, start cooling water flow. Be sure all valves in water system are open and confirm flow through the cooler. For air cooled oil cooler, make sure the louvers are open, then start the fan motor. Check fan rotation. Start the electric oil-driven pump motor. Check pump rotation. Before starting the blower(s), the oil pressure must be maintained as specified on drawings. The adjustment is on the relief valve near the oil filter.

☐ 2. If water-cooled intercooler or aftercooler are part of the package, start cooling water flow. Be sure all valves in water system are open and confirm flow through the cooler. For air cooled coolers, make sure the louvers are open before starting fan motor. Check fan rotation.

☐ 3. Open blow-off line to allow unloaded start-up of the blower.

☐ 4. Start blower, let it accelerate to full speed, then shut off. Listen for knocking sounds, both the power on and as it slows down.

☐ 5. If no problems have occurred, restart unit, partially close blow-off line and operate for 5 to 10 minutes under minimal load condition. Check motor amperage draw with an ammeter to insure that no overload is occurring. Check the cylinder surfaces all over to locate any hot spots indicating impeller rubs. Continue to listen for noise and watch for changes in vibration.

☐ 6. Re-check switches by reducing pressure and/or temperature settings and making sure they trip out the equipment. Then reset to recommended settings.

☐ 7. Increase pressure gradually and observe pressures and temperatures for any unusual readings. Continue running the unit for one (1) hour after which time all temperature readings should be stable.

☐ 8. Check relief valve for proper system protection by increasing pressure to relief point. Do this with extreme caution so as not to overload the motor or exceed the blower pressure and temperature ratings.

☐ 9. For V-belt drive units, check belt tension every eight (8) hours during the first twenty-four(24) hours. Belts have a break-in period during which they may stretch. For coupling drive units, re-check “hot” alignment after running unit at full load design conditions for one hour.

☐ 10. After 24 hours:

- Check inlet and/or discharge filter elements. Replace if necessary.
- Check oil and replace if deteriorated.
- If pressure lubricated, change oil filter.

☐ 11. Record pressures and temperatures for first week of operation at four (4) hour intervals to isolate any potential malfunctions.

## Maintenance and Service Schedule

Follow this table for maintaining and servicing the blower package at hourly intervals.

**Table 5-1. Maintenance/Service Schedule**

| Group | Inspection/ Maintenance (1) (2) | Service Interval (Hours) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 500 | 1,000 | 1,500 | 2,000 | 3,000 | 4,000 | 5,000 | 6,000 | 7,000 | 8,000 |
| Blower Package | Oil Change (3) | Replace oil based on oil analysis report or visual contamination. | | | | | | | | | |
| | Oil Analysis Mineral Oil (4) | S | S | S | S | S | S | S | S | S | S |
| | Oil Analysis Synthetic Oil (5) | - | S | - | S | - | S | - | S | - | S |
| | Oil Filters | Replace when oil is changed, if equipped. | | | | | | | | | |
| | PRV Inspection (6) | Remove PRV yearly to clean and check calibration of valve. | | | | | | | | | |
| | Coalescing Elements (7) | - | - | - | - | - | - | - | - | - | I |
| | Vane Pak | - | - | - | - | - | - | - | - | - | I |
| | Alignment Check | - | - | - | - | - | I | - | - | - | I |
| | Main Motor | Follow greasing instructions on motor nameplate. | | | | | | | | | |
| | Inspect for Leaks | I | - | - | I | - | - | I | - | - | I |
| Control Calibration | Transducers | - | - | - | - | - | I | - | - | - | I |
| | RTDs | - | - | - | - | - | I | - | - | - | I |

I = Inspect/Calibrate  S = Sampling

(1) Note: Daily Inspection Items: Check and maintain oil level. Add oil if necessary. Check for unusual noise or vibration. Check motor amps. Check pressure and temperature gauges.

(2) Note: Weekly Inspection: Check for loose bolts in piping. Check vibration. Check PRV for leaks and proper operation.

(3) Note: Recommended initial Oil is Mobil DTE 150 on the Tuthill Blowers in landfill applications. The recommended oil on Gardner Denver Cycloblower is GD AEON Synthetic oil for the warranty period. This recommendation could change based on oil analysis if it shows it breaking down quickly. Refer to Appendices for additional lubricant recommendations.

(4) Note: It is at the customer's discretion to increase or decrease the time period between oil sampling. When mineral oil is used oil needs to be checked more often until a change interval is established. Mineral oil will typically need to be changed every 1000-2000 hours. An oil sample should be taken when there is reason to believe the oil is contaminated anytime during operation. If contamination happens quickly then the blower seals should be evaluated for leaks.

(5) Note: It is at the customer's discretion to increase or decrease the time period between oil sampling. When a synthetic oil is used it will have a longer life and should not need to be checked as often but should be watched until a change interval is established. Synthetic oil will typically need to be changed every 2000-6000 hours. An oil sample should be taken when there is reason to believe the oil is contaminated anytime during operation. If contamination happens quickly then the blower seals should be evaluated for leaks.

(6) Note: It is recommended that PRVs should be removed each year to clean any build up that may happen on the inlet and outlet side of the valve and body. Depending on buildup the valve may need to be rebuilt. After valve is cleaned, the set point should be checked and recalibrated.

(7) Note: Monitor differential pressure across coalescing element and vane pak. It is recommended to inspect the coalescing and vane pak annually.

## Blowers Maintenance Instructions

For blower maintenance instructions, refer to:

- Appendix A - Tuthill PD Plus Rotary Positive Displacement Blower Installation, Operation, Maintenance and Repair Manual
- Appendix E - Gardner Denver Parts List, Operating and Service Manual, Blowers/Vacuum Pumps, 11CP-P Series

For evaluating mechanical vibration, refer to:

- Appendix F - Compressed Air and Gas Institute - Mechanical Vibration

## Motors

For motor installation, operation and maintenance instructions, refer to specific motor manufacturer instructions manual.

## Oil Pressure Switch Adjustment Instructions

For oil pressure switch adjustment instructions, refer to:

- Appendix G - Oil Pressure Switch Adjustment Instructions

## Warranty Claim Processing

This section explains how the warranty claim is processed and to help clear any questions that may arise prior to contacting customer service. For additional warranty information, refer to the Standard Vilter Warranty Statement on page i. Vilter contact information can be found on page ii.

1. The warranty process starts with contacting a Vilter Service and Warranty (S&W) department representative. *Ensure to have the original Vilter sales order number for the equipment available to better assist you.*
2. Our Vilter S&W representative will confirm if the equipment is within the warranty time frame as described in the warranty statement.

If the part is within the warranty time frame, proceed to the following section regarding the type of equipment:

1. Submit a Purchase Order (PO) to procure the replacement part:
    - The correct Vilter part number and the quantity.
    - The original Vilter sales order for the equipment.
2. Request a Return Material Authorization (RMA) number:
    - Please provide as much information describing the mode of failure to be recorded on the RMA document. This will assist us with providing a quicker review once we have received the warranty part (ex. Part does not calibrate, part does not read correct temperature, etc.).
    - Any additional parts returned on the RMA that is not listed, will be returned freight collect or scrapped. The RMA is valid for 60 days from the RMA request date.
3. After replacing the warranty part:
    - Ship the part to Vilter per the instructions on the RMA document.
    - Please include a copy of the RMA document in the box for identification purposes when the part is received.
4. Part to be evaluated.
5. Warranty Consideration:
    - Acceptance – A credit will be provided for the customer part sales order.
    - Denial – Notification of denial will be provided to the customer.

## On Site Service Support

If on site support is required, contact a Vilter S&W department representative to start this process.

1. A quote, a service rate sheet, and the service terms and conditions will be provided.
2. Submit a PO.
3. Schedule the service visit.

***Warranty does not cover labor or expenses.***
***For full Warranty Statment, see page i.***
*"...Expenses incurred by Buyer in repairing or replacing any defective product (including, without limitation, labor, lost refrigerant or gas and freight costs) will not be allowed except by written permission of Seller. Further, Seller shall not be liable for any other direct, indirect, consequential, incidental, or special damages arising out of a breach of warranty..."*

# Appendix A • Tuthill PD PLUS Rotary Positive Displacement Blower Installation, Operation, Maintenance and Repair Manual Models 1215 / 1224 / 1230 / 1236 / 1248

M-D Pneumatics™

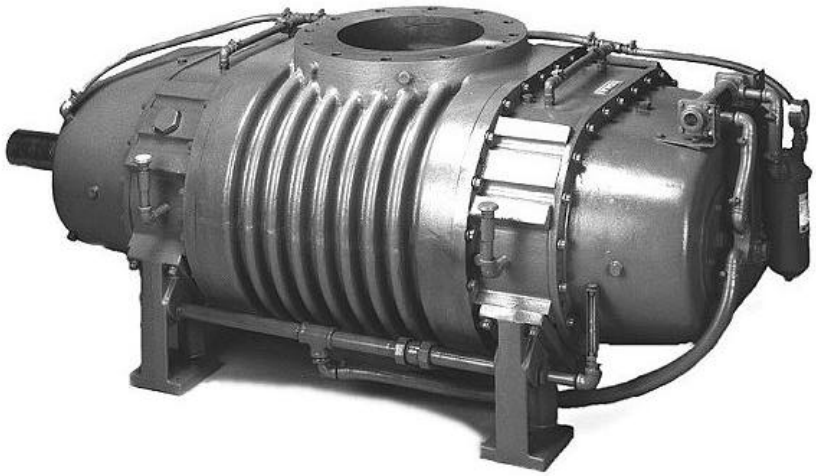
# PD PLUS®

## Rotary Positive Displacement Blower

### Series 19/86 - Lip-Labyrinth (Air Service)
### Series 55/82 - Single Envelope Gastight
### Series 66/69 - Double Envelope Gastight

**Models** 1215 1224 1230 1236 1248

# INSTALLATION
# OPERATION
# MAINTENANCE
# REPAIR
# MANUAL



***WARNING***

DO NOT OPERATE BEFORE
READING MANUAL.

REGISTERED
VACUUM & BLOWER SYSTEMS
ISO 9001
TUTHILL CORPORATION
INTERNATIONAL QUALITY STANDARD

06/2004

***LEADING THE SEARCH FOR INNOVATIVE SOLUTIONS***

TUTHILL®
**Vacuum & Blower Systems**

4840 West Kearney Street
Springfield, Missouri USA 65803-8702
Tel 417 865-8715 800 825-6937 Fax 417 865-2950
E-mail: vacuum@tuthill.com

**http://vacuum.tuthill.com**

**SAFETY INSTRUCTIONS**

1. Do not operate before reading the enclosed instruction manual.
2. Use adequate protection, warning and safety equipment necessary to protect against hazards involved in installation and operation of this equipment.





SAFETY WARNING

- Keep hands and clothing away from rotating machinery, inlet and discharge openings.
- Blower and drive mounting bolts must be secured.
- Drive belts and coupling guards must be in place.
- Noise level may require ear protection.
- Blower heat can cause burns if touched.

**NOTICE**

The above safety instruction tags were attached to your unit prior to shipment. Do not remove, paint over or obscure in any manner.

Failure to heed these warnings could result in serious bodily injury to the personnel operating and maintaining this equipment.

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**IMPORTANT**

**In order to assure you of the full benefits of our product warranty, please complete, tear out and return the warranty registration card located on the back cover of this manual, or you can visit our product registration web page at http://vacuum.tuthill.com/product_registration**

## SAFETY PRECAUTIONS

For equipment covered specifically or indirectly in this instruction book, it is important that all personnel observe safety precautions to minimize the chances of injury. Among many considerations, the following should particularly be noted:

- Blower casing and associated piping or accessories may become hot enough to cause major skin burns on contact.
- Internal and external rotating parts of the blower and driving equipment can produce serious physical injuries. Do not reach into any opening in the blower while it is operating, or while subject to accidental starting. Cover external moving parts with adequate guards.
- Disconnect power before doing any work, and avoid bypassing or rendering inoperative any safety or protective devices.
- If blower is operated with piping disconnected, place a strong, coarse screen over the inlet and avoid standing in discharge air stream.
- Avoid extended exposure in close proximity to machinery with high intensity noise levels.
- Use proper care and good procedures in handling, lifting, installing, operating, and maintaining the equipment.
- Other potential hazards to safety may also be associated with operation of this equipment. All personnel working in or passing through the area should be warned by signs and trained to exercise adequate general safety precautions.
- Hearing protection may be required depending on silencing capabilities.

# INTRODUCTION

**CONGRATULATIONS** on your purchase of a new PD PLUS® Rotary Positive Displacement Blower from Tuthill Vacuum & Blower Systems. Please examine the blower for shipping damage, and if any damage is found, report it immediately to the carrier. If the blower is to be installed at a later date make sure it is stored in a clean, dry location and rotated regularly. Make sure covers are kept on all openings. If blower is stored outdoors be sure to protect it from weather and corrosion.

PD PLUS blowers are built to exacting standards and if properly installed and maintained will provide many years of reliable service. We urge you to take time to read and follow every step of these instructions when installing and maintaining your blower. We have tried to make these instructions as straightforward as possible. We realize getting any new piece of equipment up and running in as little time as possible is imperative to production.

***WARNING:*** **Serious injury can result from operating or repairing this machine without first reading the service manual and taking adequate safety precautions.**

**IMPORTANT:** Record the blower model and serial numbers of your machine in the OPERATING DATA form below. You will save time and expense by including this reference identification on any replacement part orders, or if you require service or application assistance.

## OPERATING DATA

It will be to the user's advantage to have the requested data filled in and available in the event a problem should develop in the booster or the system. This information is also helpful when ordering spare parts.

Model No. _____

Serial No. _____
(Recorded from nameplate on unit)

Startup Date _____

Blower RPM _____

Blower Sheave Diameter _____

Motor Sheave Diameter _____

Motor RPM _____ HP _____

V-Belt Size _____ Length _____

Type of Lubrication: _____

_____

Pressure _____

Vacuum _____

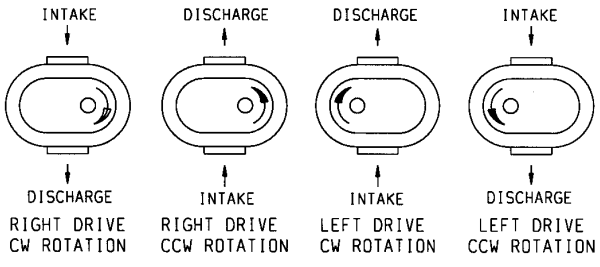
Any other special accessories with this unit

_____

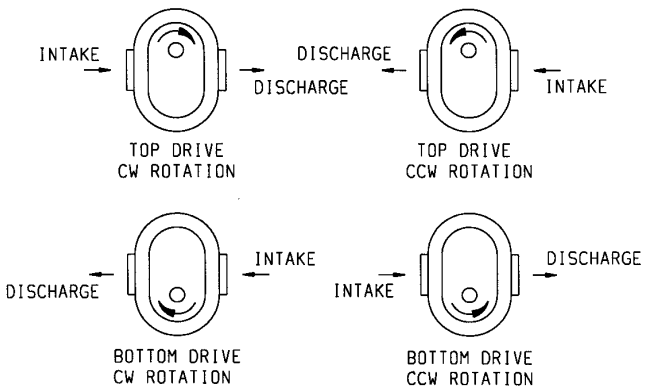
## FLOW DIRECTION BY ROTATION

Refer to the illustrations below before installing inlet and discharge piping.

**VERTICAL FLOW**



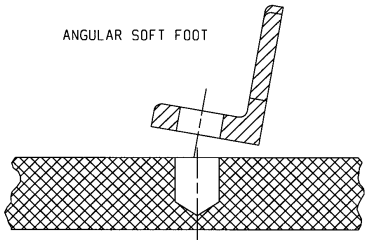

**HORIZONTAL FLOW**



## INSTALLATION

***CAUTION:*** Customers are cautioned to provide adequate protection, warning and safety equipment necessary to protect personnel against hazards involved in the installation and operation of this equipment in the system or facility.

Do not use air blowers on explosive or hazardous gases. Casing pressure must not exceed that for which the blower is rated. Each size blower has limits on pressure differential, running speed, and discharge temperature, which ***must not*** be exceeded. These limits are shown on the table "Maximum Operating Limits" on page 7.



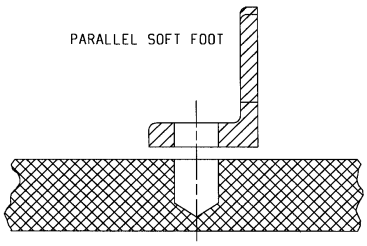




Figure 1. Examples of Soft Foot

**LOCATION**

Install the blower in a clean, dry, and well lighted area if possible. Leave plenty of room around the blower for inspection and maintenance.

**FOUNDATION**

We recommend a solid foundation be provided for permanent installation. It is necessary that a suitable base be used, such as a steel combination base under blower and motor, or a separate sole plate under each.

Before tightening the bolts, check to see that both mounting feet are resting evenly on the foundation, shim as necessary to eliminate stress on the base when the bolts are tightened.

Where a solid foundation is not feasible, care must be taken to insure that equipment is firmly anchored to adequate structural members.

**DRIVE**

When the blower is V-belt driven the sheaves must be positioned so that the hub face of the blower sheave is not more than 1/4" (6.5 mm) from the blower drive end plate and the driver sheave is as close to the driver bearing as possible. Care should be taken when installing sheave onto shaft. The faces of the sheaves should be accurately in line to minimize belt wear.

Adjust the belt tension to the belt manufacturer's specifications.

For installations where the blower is to be operated by direct drive, selection of the driver should be such as not to exceed the maximum speed ratings of the blower. (See table "Maximum Operating Limits" on page 7.)

A flexible type coupling should be used to connect driver and blower shafts. The two shafts must be aligned within .005" (.13 mm) T.I.R. (Total Indicated Runout) Coupling face run out .003 (.8 mm ) T.I.R..

**PROTECTIVE MATERIALS**

Remove protective materials from the shaft.

Remove the protective covers from the inlet and outlet ports and inspect the interior for dirt and foreign material.

***WARNING:*** **Keep hands, feet, foreign objects and loose clothes from inlet and outlet openings to avoid injury or damage if lobes are to be rotated at this point.**

**LUBRICATION**

Do not start up the blower until you are positive that it has been properly and fully lubricated. (See Lubrication Section on page 6.)

**PIPING**

Inlet and outlet connections on all blowers are large enough to handle maximum volume with minimum friction loss. Maintain same diameter piping. Silencers must not be supported by the blower. Stress loads and bending moments must be avoided.

Be certain all piping is clean internally before connecting to the blower. We recommend placing a 16-mesh wire screen backed with hardware cloth at or near the inlet connections for the first 50 hours of use until the system is clean. Make provisions to clean the screen after a few hours of operation and completely discard it once the system is clean, as it will eventually deteriorate and small pieces going into the blower can cause serious damage. A horizontal or vertical air flow piping configuration is easily achieved by rearranging the mounting feet position.

***WARNING:*** **Do not operate equipment without adequate silencing devices since high noise level may cause hearing damage. (Reference OSHA Standards.)**

**RELIEF VALVES**

We recommend the use of relief valves to protect against excessive pressure or vacuum conditions. These valves should be tested at initial start-up to be sure they are properly adjusted to relieve at or below the maximum pressure differential rating of the blower.

**CAUTION:** Upon completion of the installation, and before applying power, rotate the drive shaft by hand. It must move freely. If it does not, look for uneven mounting, piping strain, excessive belt tension or coupling misalignment or any other cause for binding. If blower is removed and still does not rotate freely, check inside the blower housing for foreign material.

# LUBRICATION

Every Tuthill Vacuum & Blower Systems blower is factory tested, oil drained and shipped dry to its installation point. Both independent oil reservoirs must be filled to the proper level before operation.

Shaft bearings at the gear end of the blower are lubricated by the method shown below for the specific series of blower. Splash lubricated series utilize one or both gears dipping into an oil reservoir formed in the gear end plate and cover. Shaft bearings at the back end of the blower are lubricated by a slinger assembly dipping into an oil reservoir.

In addition to the splash lubrication, blower series incorporating pressure lubrication with an integral oil pump, pressure relief valve, filter and oil-to-coolant heat exchanger. Before starting the blower, fill oil sumps as shown below under "Filling Procedure." Tuthill Vacuum & Blower Systems approved mineral-based, synthetic and food grade lubricants are listed on page 17.

## FILLING PROCEDURE

1. Remove large hex head fill plug from back (non-drive) end cover.
2. SLOWLY pour oil through fill until oil appears in the oil sight glass. Bring oil level to center of sight glass.
3. Verify oil level is at proper level in sight glass.
4. Replace and secure fill plug that was removed in step 1.

***CAUTION:*** Do not start the blower until you are sure oil has been put in the gear housing. Operation of the blower without proper lubrication will cause the blower to fail and void its warranty.

***WARNING:*** **NEVER ATTEMPT TO CHANGE OIL WHILE THE BLOWER IS IN OPERATION.** Failure to heed this warning could result in damage to the equipment and/or serious personal injury. **Oil level must be checked while the blower is not running.**

### SERIES DESCRIPTIONS & APPROXIMATE OIL CAPACITIES

| Series | Lubrication Type | Oil Capacity | Flow Direction | Sealing |
|---|---|---|---|---|
| 19 | Pressure | 7 gallons (26.5 liters) | Horizontal | Lip-Labyrinth seals internally, lip seal on drive shaft |
| 86 | Pressure | 10 gallons (37.9 liters) | Vertical | |
| 55 | Pressure | 7 gallons (26.5 liters) | Horizontal | Labyrinth-Mechanical seals internally, lip seal on drive shaft |
| 82 | Pressure | 10 gallons (37.9 liters) | Vertical | |
| 66 | Pressure | 7 gallons (26.5 liters) | Horizontal | Labyrinth-mechanical seals internally, mechanical seal on drive shaft |
| 69 | Pressure | 10 gallons (37.9 liters) | Vertical | |

## RECOMMENDED OIL CHANGE INTERVALS

The following should only be used as an approximate guide. For best results, an oil sampling program is recommended.

The initial oil change should occur after the first 200 hours of operation. Thereafter, frequency of oil changes will depend on the operating conditions. A general guideline chart is shown below. Check for oil contamination periodically. Time between oil changes should never exceed six (6) months.

Refer to Page 17 for approved and recommended lubricants.

| OPERATING CONDITIONS – PRESSURE/VACUUM | | | |
|---|---|---|---|
| **PSIG or inches Hg vacuum** | **mbar pressure** | **mbar vacuum** | **Operating hours between oil changes** |
| 1-5 | 70-345 | 34-170 | 1500 |
| 6-10 | 410-690 | 203-339 | 1000 |
| 11-15 | 760-1035 | 370-508 | 500 |

# PREVENTATIVE MAINTENANCE

A good maintenance program will add years of service to your blower.

A newly installed blower should be checked frequently during the first month of operation, especially lubrication. Check oil level in both the drive end and gear end of the blower and add oil as needed. Complete oil changes are recommended every 1000 operating hours, or more frequently depending on the type of oil and oil operating temperature.

The following is recommended as a minimum maintenance program.

**DAILY MAINTENANCE**

1. Check and maintain oil level, and add oil as necessary.
2. Check for unusual noise or vibration (See Troubleshooting on page 10)

**WEEKLY MAINTENANCE**

1. Clean all air filters. A clogged air filter can seriously affect the efficiency of the blower and cause overheating and oil usage.
2. Check relief valve to assure it is operating properly

**MONTHLY MAINTENANCE**

1. Inspect the entire system for leaks.
2. Inspect condition of oil and change if necessary (see page 6)

3 Check drive belt tension and tighten if necessary.

## START-UP CHECKLIST

We recommend that these startup procedures be followed in sequence and checked (v) off in the boxes provided in any of the following cases:

- During initial installation
- After any shutdown period
- After maintenance work has been performed
- After blower has been moved to a new location

| | | | | Date Checked |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|

1. Check the unit for proper lubrication. The need for proper oil level cannot be over-emphasized. Refer to Lubrication Section.

| | | | |
|---|---|---|---|

2. Check Alignment.

   For Direct Drive: Check coupling and shaft alignment.
   For Belt Drive: Check for proper belt alignment and tension.

| | | | |
|---|---|---|---|

3. Turn the rotors by hand to be certain they do not bind.

   ***WARNING:*** Disconnect power. Make certain power is off and locked out before touching any rotating element of the blower, motor or drive components.

| | | | |
|---|---|---|---|

4. "Bump" the unit with the motor a few times to check rotation and to be certain it turns freely and smoothly.

| | | | |
|---|---|---|---|

5. Start the unit and operate it for 30 minutes at no load. During this time. feel the cylinder for hot spots. If minor hot spots occur, refer to the Troubleshooting Section (page 10).

| | | | |
|---|---|---|---|

6. Apply the load and observe the operation of the unit for one hour. Check the unit frequently during the first day of operation.

| | | | |
|---|---|---|---|

7. If minor malfunctions occur, discontinue operation and refer to the Troubleshooting Section (page 10).

**MAXIMUM OPERATING LIMITS**

| MODEL | RPM | PRESSURE PSI (mbar)* | VACUUM in. Hg (mbar) * | TEMPERATURE RISE F° (C°) |
|---|---|---|---|---|
| 1215, 1224 | 1800 | 15 (1035) | 15 (508) | 280 (156) |
| 1230 | 1800 | 14 (965) | 15 (508) | 280 (156) |
| 1236 | 1800 | 9 (621) | 15 (508) | 230 (128) |
| 1248 | 1400 | 6 (414) | 10 (339) | 220 (122) |

* Pressure and vacuum levels shown are nominal, and based on air service.
Pressure capability can change depending on the gas handled.

# PRESSURE LUBRICATED SERIES 19/86, 55/82, 66/69

## OIL PRESSURE ADJUSTMENT

The oil pressure on each unit has been preset at the factory during the load testing. Generally the oil pressure should not require adjustment once the unit is installed and in operation. Some adjustment may be require due to the speed and oil temperature.

To adjust the unit to the proper oil pressure remove the hex cap shown in Figure 2 on page 9. Loosen the lock nut and turn the set screw clockwise to increase the pressure or counterclockwise to decrease the pressure. Tighten lock nut and replace cap before reading oil pressure. Always allow unit to reach operating temperature before adjusting the oil pressure to the proper range. Set the oil pressure to 15 PSIG (103 kPa).

## OIL COOLER

The supply line to the cooler can be connected to either port. The fluid flowing through the heat exchanger should be sufficient to keep the oil temperature to the optimum operating range of 150-180° F (65-80° C). This temperature will insure proper lubrication of the bearings and seals.

## OIL FILTER

**The oil filter is a self-contained, spin-on type. For best protection, Tuthill Vacuum & Blower Systems recommends changing the oil filter at each oil change, using a factory supplied filter.**

## SERVICE & REPAIRS

When ordering parts or question on servicing your blower, please have the model and serial number ready when contacting your Tuthill Vacuum & Blower Systems representative. You may contact the factory for assistance.

Tuthill Vacuum & Blower Systems
4840 West Kearney Street
Springfield, Missouri 65803-8702 USA
Tel. 417 865-8715 800 825-6937 Fax 417 865-2950
Email: mdpneumatics@tuthill.com

## APPROXIMATE DRY WEIGHT OF MODEL 1200 PD PLUS® BLOWERS

| Model | Weight, lbs. (kg) |
|---|---|
| 1215 | 3800 (1725) |
| 1224 | 4500 (2040) |
| 1230 | 5000 (2270) |
| 1236 | 5500 (2500) |
| 1248 | 6600 (3000) |

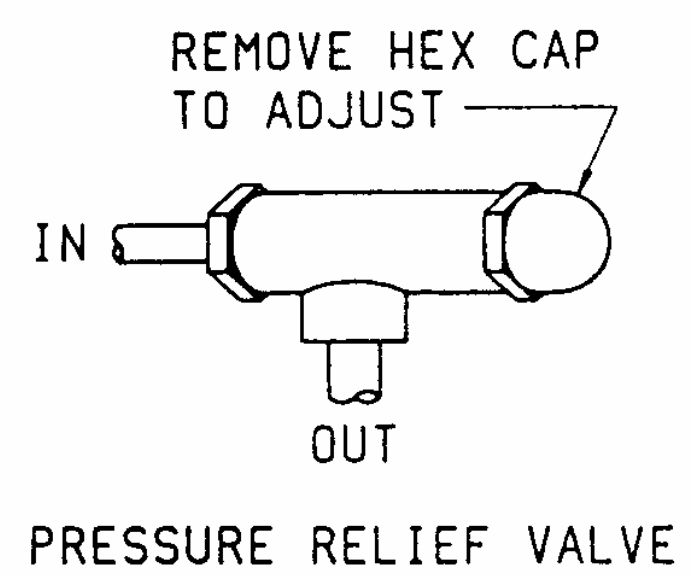
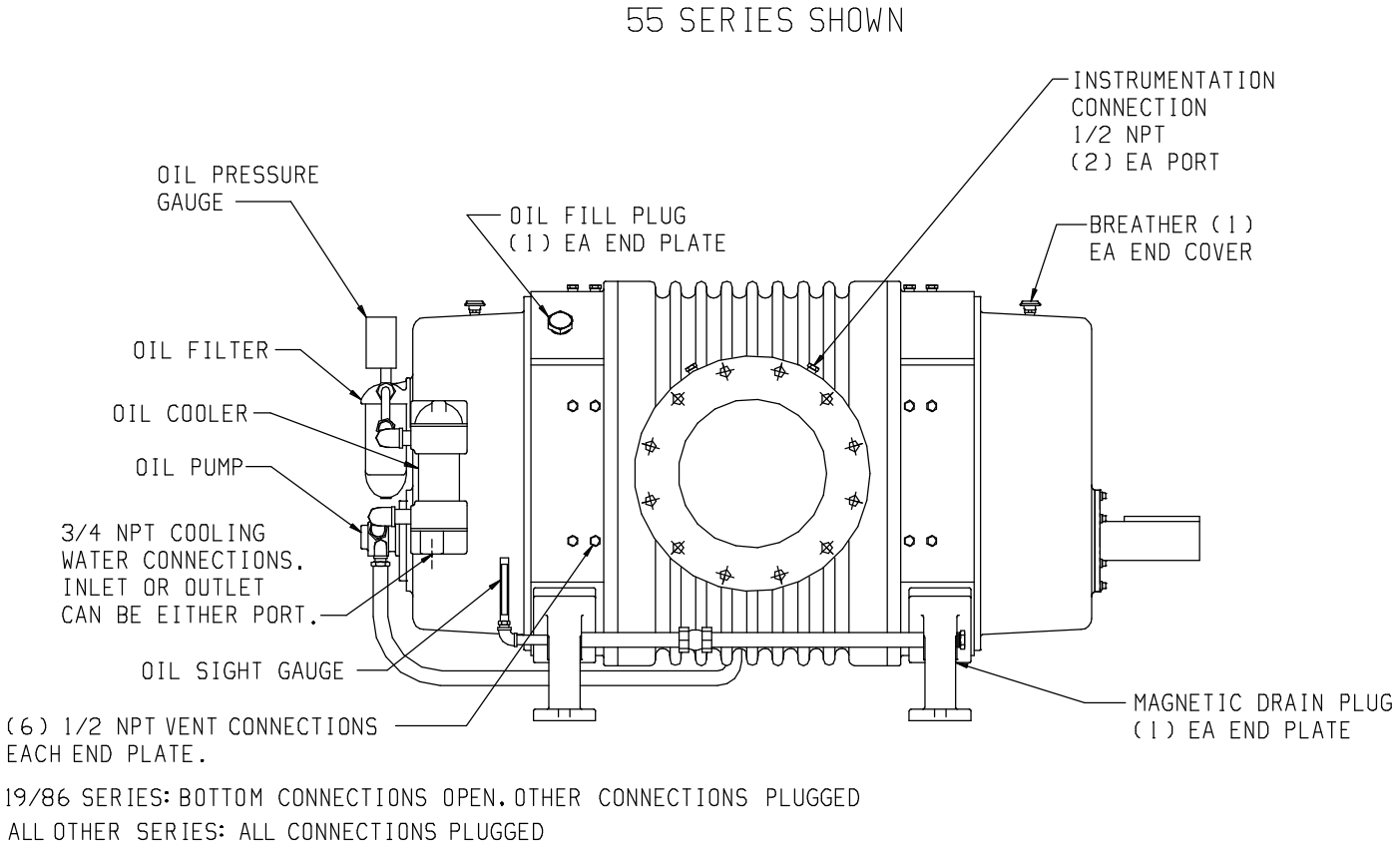



Figure 2. Adjustment of Oil Pressure



# TROUBLESHOOTING

Although **PD PLUS®** blowers are well designed and manufactured, problems may occur due to normal wear and the need for readjustment. The chart below lists symptoms that may occur along with probable causes and remedies.

| SYMPTOM | PROBABLE CAUSE | REMEDIES |
|---|---|---|
| Loss of oil. | Gear housing not tightened properly. | Tighten gear housing bolts. |
| | Lip seal failure. | Disassemble and replace lip seal. |
| | Insufficient sealant. | Remove gear housing and replace sealant. (See Disassembly and Inspection section on page 12) |
| | Loose drain plug. | Tighten drain plug. |
| Excessive bearing or gear wear. | Improper lubrication. | Correct oil level. Replace dirty oil. (See Lubrication section on page 6) |
| | Excessive belt tension. | Check belt manufacturer's specifications for tension and adjust accordingly. |
| | Coupling misalignment. | Check carefully, realign if necessary. |
| Lack of volume. | Slipping belts. | Check belt manufacturer's specifications for tension and adjust accordingly. |
| | Worn lobe clearances. | Check for proper clearances (See Assembly Clearances on page 17) |
| | Speed too low. | Increase blower speed within limits. |
| | Obstruction in piping. | Check system to assure an open flow path. |
| Knocking. | Unit out of time. | Re-time. |
| | Distortion due to improper mounting or pipe strains. | Check mounting alignment and relieve pipe strains. |
| | Excessive pressure differential. | Reduce to manufacturer's recommended pressure. Examine relief valve and reset if necessary. |
| | Worn gears. | Replace timing gears (See Disassembly and Inspection section on page 12) |
| Excessive blower temperature. | Too much or too little oil in gear reservoir. | Check oil level. (See Lubrication section on page 6) |
| | Too low operating speed. | Increase blower speed within limits. |
| | Clogged filter or silencer. | Remove cause of obstruction. |
| | Excessive pressure differential. | Reduce pressure differential across the blower. |
| | Elevated inlet temperature. | Reduce inlet temperature. |
| | Worn lobe clearances. | Check for proper clearances (See Assembly Clearances on page 17) |
| Rotor end or tip drag. | Insufficient assembled clearances. | Correct clearances (See Assembly Clearances on page 17) |
| | Case or frame distortion. | Check mounting and pipe strain. |
| | Excessive operating pressure. | Reduce pressure differential. |
| | Excessive operating temperature. | Reduce pressure differential or reduce inlet temperature. |
| Vibration. | Belt or coupling misalignment. | Check carefully, realign if necessary. |
| | Lobes rubbing. | Check cylinder for hot spots, then check for lobe contact at these points. Correct clearances (See Assembly Clearances on page 17) |
| | Worn bearings or gears. | Check condition of gears and bearings; replace if necessary. |
| | Unbalanced or rubbing lobes. | Possible buildup on casing or lobes, or inside lobes. Remove buildup and restore clearances. |
| | Driver or blower loose. | Check mounting and tighten if necessary. |
| | Piping resonance. | Check pipe supports, check resonance of nearby equipment, check foundation. |

# RECOMMENDED SHUTDOWN PROCEDURE TO MINIMIZE RISK OF FREEZING OR CORROSION

When high humidity or moisture is present in an air piping system, condensation of water can occur after the blower is shut down and the blower begins to cool. This creates an environment favorable to corrosion of the iron internal surfaces, or in cold weather, the formation of ice. Either of these conditions can close the operating clearances, causing the blower to fail upon future start-up.

The following shutdown procedure outlined below minimizes the risk of moisture condensation, corrosion and freezing. **Care must be taken so as not to overload or overheat the blower during this procedure.**

1. Isolate the blower from the moist system piping, allowing the blower to intake atmospheric air. Operate the blower under a slight load allowing the blower to heat within safe limits. The heat generated by the blower will quickly evaporate residual moisture.

2. For carpet cleaning applications, after the work is completed, simply allow the blower to run a few (3-5) minutes with the suction hose and wand attached. The suction hose and wand will provide enough load to the blower to evaporate the moisture quickly.

3. For extended shutdown, inject a small amount of a light lubricating oil such as 3-in-One® or a spray lubricant such as WD-40® into the inlet of the blower just prior to shutdown. The lubricant will provide an excellent protective coating on the internal surfaces. If using a spray lubricant, exercise care to prevent the applicator tube from getting sucked into the blower. The applicator tube will damage the blower, most likely to the point that repair would be required.

January, 2001

3-in-One and WD-40 are registered trademarks of WD-40 Company.

# DISASSEMBLY AND INSPECTION

1. Drain lubrication from either end and disconnect all external oil lines. Units manufacture prior to 1986. Do not attempt to remove oil distribution line **bushing** in the non-drive end plate until the end cover has been removed and the internal fittings are disconnected. The oil filter and heat exchanger may be removed or left fastened to the cover. Mark piping and other parts so that they can go back in their original position when reassembling.

## FREE END DISASSEMBLY

2. Support free end cover (7) using a lifting strap. Remove cap screws (26) and install two of them as jacking screws in the tapped holes next to the dowel pins. It is recommended that two studs 8" long be used to assist in supporting the cover until it has cleared the dowel pins. It is not necessary to remove oil pump (144) and the adapter plate (313) from the cover unless these items are being replaced.

3. Remove large O-ring (302), four slinger cap screws (309) (5/16-12 point socket required), and oil slinger (20). Tap drive shaft (310) lightly with a mallet to remove from rotor shaft. Remove cap screws (30) and the oil retaining rings (15).

## GEAR END DISASSEMBLY

4. Remove drive shaft key (23). Remove all burrs and other defacements from the drive shaft. All series except 66/69. Remove cap screws (30) and place two screws in jackscrew holes provided to remove seal adapter plate (46). Tap out the seal and discard O-ring (314).

   **Series 66/69:** Remove cap screws (30 & 93). Remove seal housing (91) and remove stator portion of the mechanical seal (76B). Using a spanner wrench, remove the adapter sleeve (87) by turning counter clockwise. Remove mating ring (76A) and O-rings (88 & 140).

5. Support drive end cover (6) as done on the non drive end. Remove cap screws (26). The drive end cover also has jacking screw holes, but it must slide off the spherical roller bearing on the drive shaft. To keep the bearing outer race from cocking, it is suggested that the drive shaft bearing pressing tool shown on page 22 be used.

6. Remove cap screws (66) and drive shaft (45). The bearing (50) should be pulled now unless it is to be pressed apart after the drive shaft has been removed.

7. Stand the blower up on the non drive end on 6"x 6" blocks remove cap screws (326) from the driven gear and align the match marks on the timing gear teeth (8). Using a suitable puller or extended pry bar, remove the gear shell from their hubs. The shell and hub are matched, do not inter-change. Remark if the original markings are no longer visible.

8. Unlock spanner nut lockwashers (36) and remove spanner nut (35) and lockwashers. Remove gear hubs with puller. Remove gear keys (24).

9. Remove oil sight gauge (70). Remove cap screws (307) and mounting feet (304), Series 66& 69 have feet (304) and (408). All feet are mounted on 1 1/8" hollow locating dowels (306) from which they should easily disengage by tapping lightly with a mallet. Discard O-rings (305).

10. Remove cap screws (30) bearing retainer rings (14) and end plate cap screws.

## END PLATE & ROTOR DISASSEMBLY

11. The end plate, with the bearings, must be pulled from the rotor shafts. Make up two Bearing Pressing Fixtureplates shown on page 23 along with eight pieces of 1/2x13 all thread, flat washers, and hex nuts. The use of a hydraulic ram is also recommended but some modifications may be necessary depending on the type of equipment available. Install each plate to the bearing retainer ring mounting holes and apply pressure equally to the ends of the rotor shaft by tightening the nuts on the threaded rods. Install spacers under plate after rotor shafts become flush with top of bearing. Use a hoist to pick up the end plate once the bearings have cleared the shaft.

12. After the end plate is removed, tap out the bearings (9). Remove large O-ring (176).

    **Series 19/86:** Tap out lip seals (12).

    **Series 55/82/66/69:** Pull out by hand the stator portion on the mechanical seal (54). Retain the seal adapter (74) for reassembly.

    **NOTE: If the rotor shaft sleeves (239) were removed with the end plate, pull them out by hand on the 19/86 series. On the other series you must drive them out with the bearings. To avoid damage to the sleeves do not use any hard faced hammers or steel punches to drive the sleeves out. Separate the mating rings from the sleeves.**

13. To replace the Teflon washers of the labyrinth seals, remove the retaining ring (219), two wave springs (282), steel spacers (281), and Teflon washers (280).

    **NOTE: Older units will contain six Teflon and seven steel washers in each bore. The current Teflon washers are thicker, therefore you will only use five Teflon and six steel washers when reassembling.**

14. Reinstall the end plate without the bearings and seals and secure with six cap screws equally spaced. Turn the unit over and support with block under the gear end plate.

15. Repeat steps 8,11,12 and 13 to remove non-drive end plate.

    **NOTE: Do not damage bearing spacer (123) when removing bearings. This spacer is only used on the free end.**

16. Lift the rotors (1) out of the housing (3). Unbolt the gear end plate and lift the housing off. Clean all parts and Inspect for wear. It is not necessary to remove the oil distribution fittings on the end plates and the gear cover but they should be checked with compressed air to be sure the five orifices are not clogged.

# ASSEMBLY

The assembly procedure is generally the same for all series, but where there are differences, notations will be made. All joints between housing, end plate, and covers are O-ring sealed. An RTV silicone sealer or equal is used on the lip seals and mounting feet.

Dowel pins are used to locate end plate, housing, and covers in the proper location relative to each other. It is recommended that the gear end rotor shaft bearings along with all other replacement parts be purchased from Tuthill Vacuum & Blower Systems, to insure the rotor location is correct with the proper end clearance relative to the gear end plate.

## PREPARATION OF END PLATES

1. Make sure all parts are and free of any nicks or burrs caused by disassembly. See pages 22-24 for dimensions of the seal installation tools.

2. Position end plate with bearing bores up (flange side down) and install components of the labyrinth seals. Staring with a Teflon washer (200) alternately stack five Teflon and five steel spacers in each bore. Add two wave springs, one more steel spacer and a retaining ring. Compress to seat seal.

   **NOTE: Two wave springs are necessary for the proper pressure on the seal, but because of the pressure a tool as shown on page 23 is needed to press the retainer ring into its groove. The tool will center the labyrinth seal as it presses the retainer ring in place.**

3. **Series 19/86:** Apply sealer to the O.D. of the lip seal. Install with lip facing upward. Tap in place with installation tool shown on page 22. Apply grease to lip of seal.

   **Series 55/82/66/69:** Install seal adapter (74). The adapter is used to anchor the stator portion of the mechanical seal (54). To install the seal, grease both the O-ring and seal bore, then push the seal, by hand, into the bore and against the seal adapter, making sure the two dimples on the bottom of the seal case are aligned with the holes in the seal adapter. Clean surface with soft tissue and acetone.

   **CAUTION: Never drive mechanical seal or seal tool with any type of hammer. This could result in damage to the carbon or its ability to properly seal.**

## GEAR END ASSEMBLY

4. Place non-drive end plate on 6"x 6" blocks with the solid side up. The end plate must be blocked up so rotor shafts will not touch floor when they are installed. Grease and install O-ring (176) in end plate groove. Install housing (3) making sure dowel pins are in place. Do not bolt in place at this time.

5. Lay two pieces of steel approximately 2" x 2" x 1/8" thick at the bottom of the housing as shown in Figure 3 with the end (long shafts) up. The rotor lobes will be above the end of the housing which is necessary when assembling this end.

6. Grease and install O-ring (176) in groove of gear end plate. Use sufficient grease to hold it into place when the end plate is turned over.

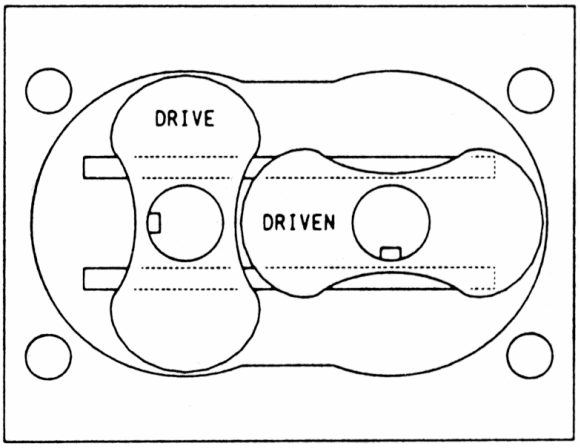



Figure 3. Positioning of Rotors & Housing for Assembly

7. Install the end plate on the rotors and housing. The end plate will rest on the ends of the rotor lobes, and there will be a space between the housing and the plate. Install all cap screws (301) and tighten end plate to housing until tight.

8. Use six cap screws (301) equally spaced and secure non drive end plate against shims at bottom end of rotors. Do not torque these bolts.

9. Grease O-ring (331) and start onto rotor shaft.

   **Series 19/86:** Start sleeve 9239) over shaft (larger diameter down) while forcing O-ring into step at the bottom of the sleeve. Slide sleeve down the shaft until seated. You may encounter interference as the sleeve passes through the Teflon rings. Tap sleeve with mallet to seat if necessary.

   **Series 55/82/66/69:** Grease internal O-ring of mating ring portion of seal (Assemble mating ring over sleeve (236) with lapped surface down. Slot in mating ring must line up with pin in sleeve and be flush with top of sleeve when properly installed. Clean lapped surface of mating ring with soft tissue and acetone. Lubricate surface and start sleeve over rotor shaft while forcing O-ring into step at bottom of sleeve. Carefully slide this assembly down the shaft until seated.

10. Coat the rotor shaft with an anti-seize lubricant and press the bearing (9) on the shaft. The bearing manufacturer numbers and/or an acid dot (inner race) should be up or toward the gears. Use the same plates used to disassembly and a sleeve to press on the inner race of the bearing when installing.

11. Loosen cap screws holding non-drive end plate to housing then install bearing retainer rings (14) and secure with cap screws (30). At this time check clearances between the rotor lobes and gear end plate. See page 17 for the correct gear end clearances. If clearances are not within specifications, recheck parts to find cause of improper clearances before proceeding. Retighten the cap screws on the non-drive end but do not torque at this time.

12. Install keys (24) into rotor shafts. Tight fit required. Coat shafts and key with anti-seize. If new gears are being installed, disassembly gear shell from hub.

13. Heat the gear hubs to 350° F (177° C) At this temperature they should fit easily to the rotor shafts.

    **CAUTION: After heating, handle gear hubs with insulated gloves only.**

    Secure with lockwashers (36) and locknut (35) immediately after hub is installed. Torque to proper specification. Do not install gear shell until hub has been allowed to cool.

## FREE END ASSEMBLY

14. Turn assembly over and support on blocks. Remove the six cap screws and put jack screws in the holes provided in the flange of the end plate and remove plate. Take out two shims and check free end clearance between end of the lobes and housing using a flat bar and feeler gauges or a depth micrometer. See page 17 for correct clearances.

    **Series 19/86:** Repeat step 9 to install sleeves.

15. **Series 55/82/66/69:** Recheck carbon of seal to be sure it is clean.

    **All series:** Reinstall end plate making sure O-ring is still in its groove and secure with all the cap screws (26).

16. Series 55/82/66/69: Repeat step 9 install sleeve and mating ring assemblies.

17. Install bearing spacers (123) then repeat step 10 to install bearings. Secure with lockwashers and locknuts (936 & 35). Bend one lockwasher tap into spanner nut slot to lock all nuts).

18. Install oil retainer rings (15) and cap screws (30) (only six required).

19. To install mounting feet (304) or (304 & 408 on 66/69 series) the hollow dowel (306) should be in the foot. If any of the dowels are in the end plate, remove and transfer to the feet. Grease and install the O-ring over dowel. Run a bead of silicone sealer 1/4" wide, around the dowel holes on the foot mounting pad of the end plate. This acts as a backup O-ring to prevent any oil leakage. Secure with cap screw (307). Reconnect oil pipes then stand unit on its feet.

20. The gear hub should now be cool enough to assemble the gear shells. The dowel pins should be in the hub. Transfer if necessary. Reinstall the timing shim and assemble the shells to their proper hubs (align hubs and shell match marks). Install drive gear first (right hand helix) the align the match marks on the teeth and assemble driven gear (left hand helix).

    **NOTE: The six cap screws that were in the drive gear are too long without the drive shaft. Temporarily use the six cap screws from the driven gear. Use three in each gear (every other hole).**

## ADJUSTING INTERLOBE CLEARANCE

21. The timing gears are made up of two pieces. The outer gear shells are fasten to the inner hubs with six cap screws and located with two dowel pins. By adding shims between the gear shell and the inner hub the gear is moved axially relative to the inner hub which is mounted on the rotor shaft. Being a helical gear , it rotates as it is moved out and the rotor turns with it, thus changing the clearances between the two rotor lobes. Adding .012" shim thickness will change the rotor lobe clearance by .003".

    The timing shim is formed from a number of .003" shims which have been laminated together. They are easily peeled off as necessary.

    Using feeler gauges to check the clearance at AA ( right-hand reading) and BB (left-hand reading. See Figure 4. The clearances should be adjusted so they are as equal between all lobes as possible, usually within .003" to .004". For best results use feeler gauges no larger than .006".

    **EXAMPLE:** If AA reading is .030" and BB reading is .022", by removing .016" shim the reading will change about .004". AA reading will decrease to .026" and BB reading will increase to .026". To determine the amount of shim to add or subtract the two readings .030" - .022" = .088" and double the result .008" x 2 = .016". To determine whether to add or remove this amount the following rule will always apply.

    If the right side reading (AA) is greater than the left side reading (BB) , remove this amount. If the right side reading (AA) is less than the left side reading (BB), then add this amount.

    **NOTE: If the results require you to remove shim from the driven gear and there are no shims left under this gear, go to the drive gear and add this amount for the same result. When removing or replacing a gear for shimming the timing mark should be matched and on center. Either gear may be pulled in this position.**

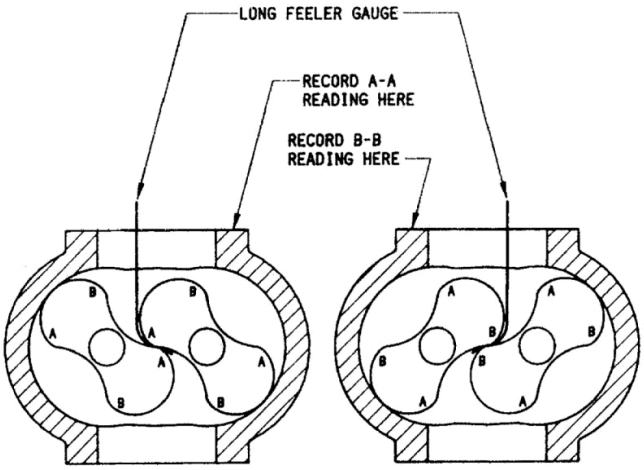


Figure 4. Checking Interlobe Clearance

## COMPLETING GEAR END ASSEMBLY

22. Press drive shaft bearing (50) on drive shaft (45). Remove the three cap screws from drive gear and install in the drive gear. Clean and remove all burrs from mating surfaces of the gear and drive shaft flange. Install with cap screws (66).

    Torque gear cap screws at this time. Check drive shaft run out at the seal journal. Do not exceed .003" T.I.R.

    **Series 19/86/55/82:** Secure bearing with Lockwasher (320) and locknut (319). Bend over tab to lock in place.

23. Grease and install O-ring (302). To aid in the installation of the gear cover (6) a tool as shown on page 22 should be made to hold the outer race of the bearing square with the shaft. Side the cover over the tool and secure with cap screws (26).

24. **Series 19/86/55/82:** Press lip seal (13) into adapter plate (46) with lip facing inward. Grease lip , install O-ring (314) then carefully install assembly over drive shaft.

    **Series 66/69:** Grease and install O-ring (140) on adapter flange and O-ring (88) in the bore of adapter. Clean mating ring (76A) with soft tissue and acetone and install on adapter while aligning pin (300) with slot in mating ring. The larger surface area of the mating ring face inward. Install retaining ring (78), using spanner wrench. Tighten set screws (90).

    Lubricate seal O-ring and hand press seal (76B) into the seal housing (91) making sure to align the two dimples on the bottom of the seal with corresponding holes in the seal housing. Clean carbon surface with soft tissue and acetone. Grease and install O-ring (314) around the seal bore. Place a few drops of lubricating oil on the mating ring, then carefully install assembly over the drive shaft on to the cover. Secure with cap screws (30 & 93).

## COMPLETING FREE END ASSEMBLY

25. Grease and install O-ring (302) in end plate groove. Install oil pump drive shaft (310) and oil slinger (20) on rotor shaft and secure with cap screws (309).

26. Align drive shaft slot with oil pump tang and carefully slide cover over shaft and onto dowel pins in end plate. Tap cover gently until contact with O-ring is made. If gap remains recheck slot and tang alignment for proper engagement. Secure cover with cap screws (26).

    **NOTE: If oil pump assembly (144) is being replaced, install cover first, then install O-ring (325) and oil pump.**

27. Complete assembly by reinstalling or connecting all remaining oil lines, sight glass, etc. Oil filter element should always be replaced with factory filter when overhauling a unit. Fill with lubricant to proper level on column sight glass.

# NOTES

# PD PLUS®

## MAINTENANCE AND SERVICE SPECIFICATIONS SHEET
## MODELS 1215, 1224, 1230, 1236, 1248

| CLEARANCES | | | | |
|---|---|---|---|---|
| **MODEL** | **GEAR END** | **FREE END** | **INTERLOBE** | **TIP-PORT** |
| **1215** | .009 – .015 (.23 – .38) | .022 – .029 (.56 – .74) | .025 – .032 (.63 – .81) | .021 – .027 (.53 – .69) |
| **1224** | | .031 – .038 (.79 – .96) | | |
| **1230** | | .037 – .044 (.94 – .1.12) | | |
| **1236** | | .043 – .050 (1.09 – 1.27) | | |
| **1248** | | .055 – .064 (1.40– 1.63) | | |

## RECOMMENDED LUBRICANTS

**RECOMMENDED MINERAL BASED LUBRICANTS**

| AMBIENT TEMPERATURE | SHELL | CITGO | CHEVRON TEXACO | EXXONMOBIL |
|---|---|---|---|---|
| **0° F (-18° C) to 32° F (0° C)** | TELLUS® PLUS 68 (ISO 68) | A/W 68 (ISO 68) | RANDO HD 68 (ISO 68) | DTE HEAVY MEDIUM (ISO 68) |
| **32° F (0° C) to 90° F (32° C)** | TELLUS PLUS 100 (ISO 100) | A/W 100 (ISO 100) | RANDO HD 100 (ISO 100) | DTE HEAVY (ISO 100) |
| **90° F (32° C) to 120° F (50° C)** | TELLUS PLUS 150 (ISO 150) | A/W 150 (ISO 150) | RANDO HD 150 (ISO 150) | DTE EXTRA HEAVY (ISO 150) |

**RECOMMENDED SYNTHETIC LUBRICANTS**

| AMBIENT TEMPERATURE | TUTHILL | EXXONMOBIL | SHELL |
|---|---|---|---|
| **0° F (-18° C) to 32° F (0° C)** | **PneuLube™** (ISO 100) | SHC 626 (ISO 68) | MADRELA® AS 68 (ISO 68) |
| **32° F (0° C) to 90° F (32° C)** | | SHC 627 (ISO 100) | MADRELA P 100 (ISO 100) |
| **90° F (32° C) to 120° F (50° C)** | | SHC 629 (ISO 150) | MADRELA® P 150 (ISO 150) |

**NOTE:** Tuthill Vacuum & Blower Systems cannot accept responsibility for damage to seals, O-rings and gaskets caused by use of synthetic lubricants not recommended by Tuthill Vacuum & Blower Systems.

***** Blowers used in oxygen-enriched service should use **only** Castrol Brayco 1726 Plus non-flammable, PFPE synthetic lubricant.

Blowers used in hydrogen service should use only **PneuLube** synthetic oil.

**RECOMMENDED MINERAL BASED, FOOD GRADE LUBRICANTS**

| AMBIENT TEMPERATURE | Lubricant meeting U.S. FDA regulations 21 CFR 172.878 and 178.3620(a) for direct and indirect food contact | Lubricant meeting U. S. FDA regulation 21 CFR 178.3570 governing petroleum products which may have incidental contact with food (formerly USDA H1 requirements) |
|---|---|---|
| **0° F (-18° C) to 32° F (0° C)** | CITGO CLARION® 350 FOOD GRADE (ISO 68) | CITGO CLARION® A/W 68 (ISO 68) |
| **32° F (0° C) to 90° F (32° C)** | CONSULT FACTORY | CITGO CLARION® A/W 100 (ISO 100) |
| **90° F (32° C) to 120° F (50° C)** | CONSULT FACTORY | CONSULT FACTORY |

# PD PLUS

## PARTS LIST - MODEL 1215, 1224, 1230, 1236, 1248; SERIES 19/86, 55/82

**SERIAL NUMBER(S)_____**

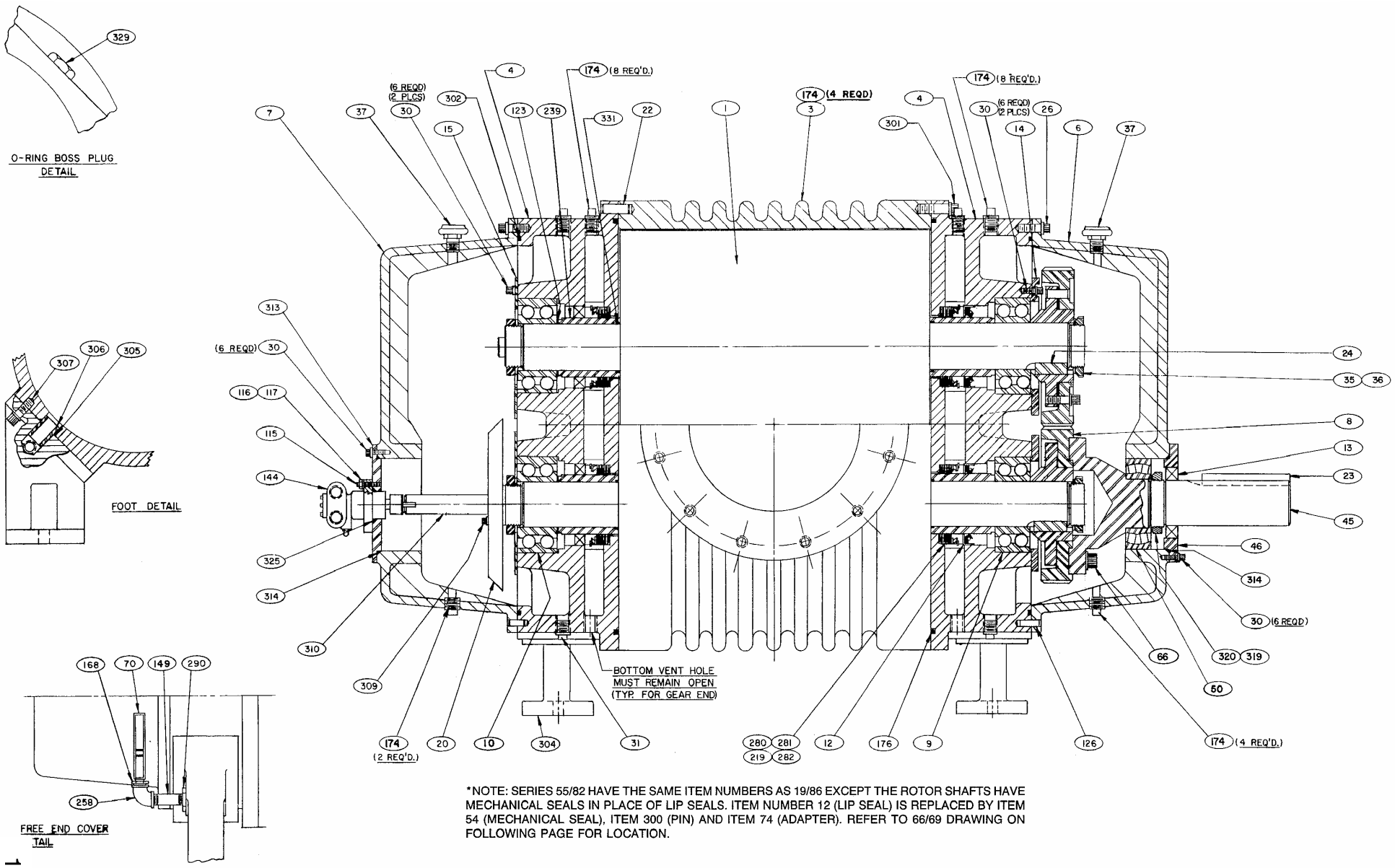
**When ordering parts, use the item number shown, plus your model, series and serial number. For Series 66/69, please refer to page 20.**

| Item No. | Description | 19/86 | 55/82 | Item No. | Description | 19/86 | 55/82 | Item No. | Description | 19/86 | 55/82 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Rotor | 2 | 2 | 37 | Breather | 2 | 2 | 281 | Spacer (Lab Seal) | 24 | 24 |
| 3 | Housing | 1 | 1 | 45 | Drive Shaft | 1 | 1 | 282 | Wave Spring (Lab Seal) | 8 | 8 |
| 4 | End Plate | 2 | 2 | 46 | Seal Adapter | 1 | 1 | 300 | Spring Pin | - | 4 |
| 6 | Gear End Cover | 1 | 1 | 50 | Bearing | 1 | 1 | 301 | Cap Screw | 48 | 48 |
| 8 | Timing Gear Assembly | 1 | 1 | 54 | Mechanical Seal | - | 4 | 302 | O-Ring | 2 | 2 |
| 9 | Bearing GE | 2 | 2 | 66 | Cap Screw | 6 | 6 | 304 | Foot | 4 | 4 |
| 10 | Bearing FE | 2 | 2 | 70 | Oil Sight Glass | 1 | 1 | 305 | O-Ring | 4 | 4 |
| 12 | Lip Seal | 4 | - | 74 | Adapter | - | 4 | 306 | Sleeve | 4 | 4 |
| 13 | Lip Seal | 1 | 1 | 115 | Stud | 3 | 3 | 307 | Cap Screw | 16 | 16 |
| 14 | Bearing Retaining Plate | 2 | 2 | 116 | Hex Nut | 3 | 3 | 309 | Cap Screw | 4 | 4 |
| 15 | Oil Retaining Ring | 2 | 2 | 117 | Lockwasher | 3 | 3 | 310 | Adapter | 1 | 1 |
| 20 | Oil Slinger | 1 | 1 | 123 | Bearing Spacer | 2 | 2 | 313 | Adapter | 1 | 1 |
| 22 | Dowel Pin | 4 | 4 | 125 | Bracket | 1 | - | 314 | O-Ring | 2 | 2 |
| 23 | Drive Shaft Key | 1 | 1 | 126 | Dowel Pin | 4 | 4 | 319 | Locknut | 1 | 1 |
| 24 | Timing Gear Key | 2 | 2 | 144 | Pump Assembly | 1 | 1 | 320 | Lockwasher | 1 | 1 |
| 26 | Cap Screw | 48 | 48 | 174 | Pipe Plug | AR | AR | 325 | O-Ring | 1 | 1 |
| 30 | Cap Screw | 36 | 36 | 176 | O-Ring | 2 | 2 | 329 | Boss Plug | 2 | 2 |
| 31 | Magnetic Plug | 2 | 2 | 219 | Retaining Ring (Lab Seal) | 4 | 4 | 331 | O-Ring | 4 | 4 |
| 35 | Locknut | 4 | 4 | 239 | Sleeve | 4 | 4 | | | | |
| 36 | Lockwasher | 4 | 4 | 280 | Teflon Washer (Lab Seal) | 20 | 20 | | | | |
| | | | | | | | | AR - (As Required) | | | |
| **ITEM NUMBERS NOT SHOWN ON ASSEMBLY DRAWINGS** | | | | | | | | | | | |
| 124 | Oil Filter (Complete) | 1 | 1 | 173 | Heat Exchanger | 1 | 1 | 262 | Oil Pressure Gauge | 1 | 1 |
| 125 | Bracket, Heat Exchanger | 1 | 1 | 186 | Bracket, Heat Exchanger | 1 | 1 | | | | |

# PD PLUS

## CUTAWAY VIEW - MODEL 1215, 1224, 1230, 1236, 1248; SERIES 19/86, 55/82

**For Series 66/69, please refer to page 21.**




*NOTE: SERIES 55/82 HAVE THE SAME ITEM NUMBERS AS 19/86 EXCEPT THE ROTOR SHAFTS HAVE MECHANICAL SEALS IN PLACE OF LIP SEALS. ITEM NUMBER 12 (LIP SEAL) IS REPLACED BY ITEM 54 (MECHANICAL SEAL), ITEM 300 (PIN) AND ITEM 74 (ADAPTER). REFER TO 66/69 DRAWING ON FOLLOWING PAGE FOR LOCATION.

# PD PLUS

## PARTS LIST - MODEL 1215, 1224, 1230, 1236, 1248; SERIES 66/69

**SERIAL NUMBER(S)_____**

**When ordering parts, use the item number shown, plus your model, series and serial number.**

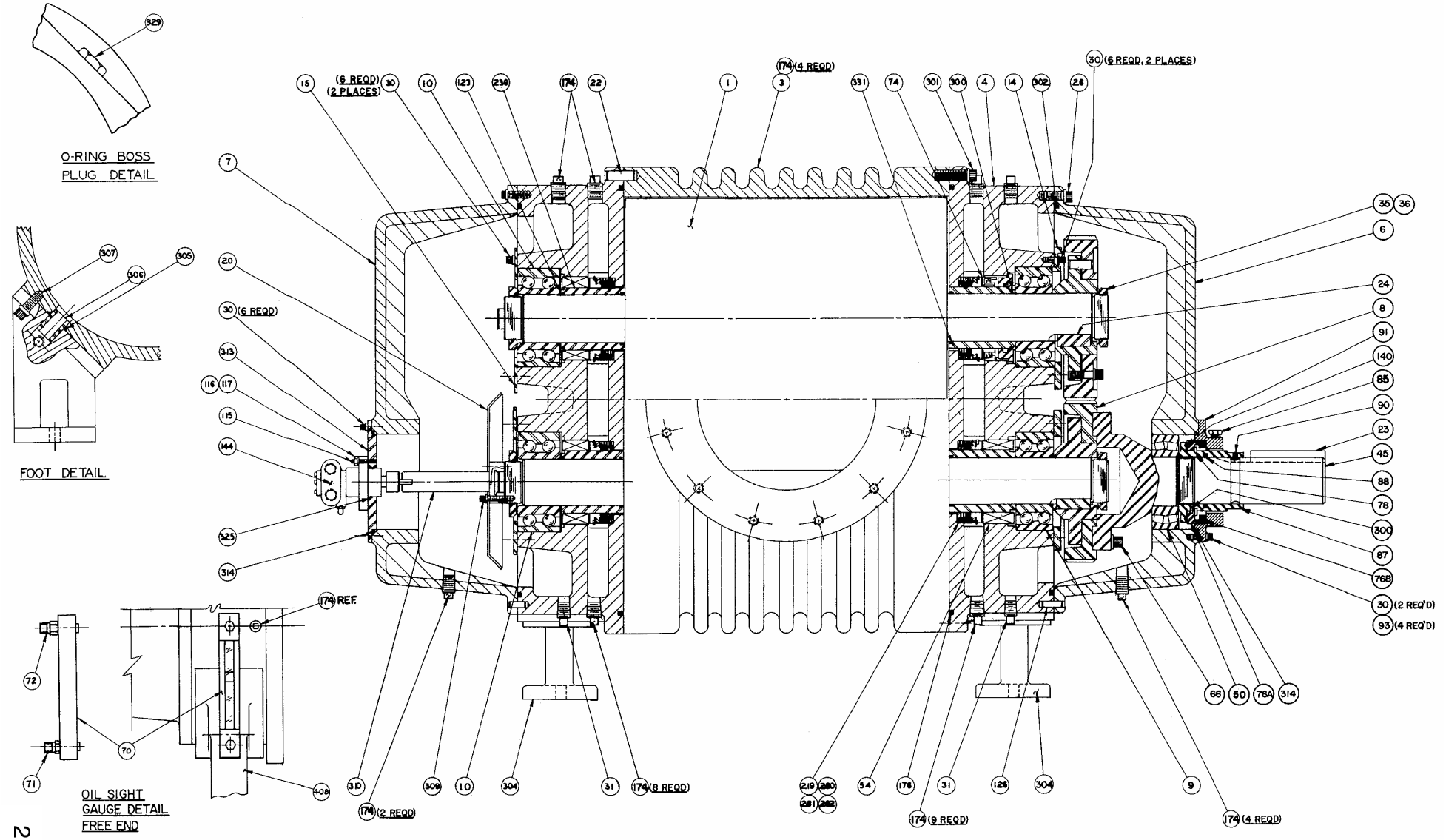
**For Series 19/86 & 55/82, please refer to page 18.**

| Item No. | Description | 66/69 | Item No. | Description | 66/69 | Item No. | Description | 66/69 |
|---|---|---|---|---|---|---|---|---|
| 1 | Rotor | 2 | 70 | Oil Sight Glass | 1 | 219 | Retaining Ring (Lab Seal) | 4 |
| 3 | Housing | 1 | 71 | Adapter | 1 | 239 | Sleeve | 4 |
| 4 | End Plate | 2 | 72 | Adapter | 1 | 280 | Teflon Washer (Lab Seal) | 20 |
| 6 | Gear End Cover | 1 | 74 | Adapter | 4 | 281 | Spacer (Lab Seal) | 24 |
| 8 | Timing Gear Assembly | 1 | 76A | Mating Ring | 1 | 282 | Wave Spring (Lab Seal) | 8 |
| 9 | Bearing GE | 2 | 76B | Mechanical Seal | 1 | 300 | Spring Pin | 5 |
| 10 | Bearing FE | 2 | 78 | Retaining Ring | 1 | 301 | Cap Screw | 48 |
| 14 | Bearing Retaining Plate | 2 | 85 | Pipe Plug | 4 | 302 | O-Ring | 2 |
| 15 | Oil Retaining Ring | 2 | 87 | Adapter | 1 | 304 | Foot | 3 |
| 20 | Oil Slinger | 1 | 88 | O-Ring | 1 | 305 | O-Ring | 4 |
| 22 | Dowel Pin | 4 | 90 | Socket HD Set Screw | 2 | 306 | Sleeve | 4 |
| 23 | Drive Shaft Key | 1 | 91 | Seal Adapter | 1 | 307 | Cap Screw | 16 |
| 24 | Timing Gear Key | 2 | 93 | Cap Screw | 4 | 309 | Cap Screw | 4 |
| 26 | Cap Screw | 48 | 115 | Stud | 3 | 310 | Adapter | 1 |
| 30 | Cap Screw | 32 | 116 | Hex Nut | 3 | 313 | Adapter | 1 |
| 31 | Magnetic Plug | 2 | 117 | Lockwasher | 3 | 314 | O-Ring | 2 |
| 35 | Locknut | 4 | 123 | Bearing Spacer | 2 | 325 | O-Ring | 1 |
| 36 | Lockwasher | 4 | 126 | Dowel Pin | 4 | 329 | Boss Plug | 2 |
| 45 | Drive Shaft | 1 | 140 | O-Ring | 1 | 331 | O-Ring | 4 |
| 50 | Bearing | 1 | 144 | Pump Assembly | 1 | 408 | Foot | 1 |
| 54 | Mechanical Seal | 4 | 174 | Pipe Plug | AR | | | |
| 66 | Cap Screw | 6 | 176 | O-Ring | 2 | AR - (As Required) | | |
| **ITEM NUMBERS NOT SHOWN ON ASSEMBLY DRAWINGS** | | | | | | | | |
| 124 | Oil Filter (Complete) | 1 | 173 | Heat Exchanger | 1 | 262 | Oil Pressure Gauge | 1 |
| 125 | Bracket, Heat Exchanger | 1 | 186 | Bracket, Heat Exchanger | 1 | | | |

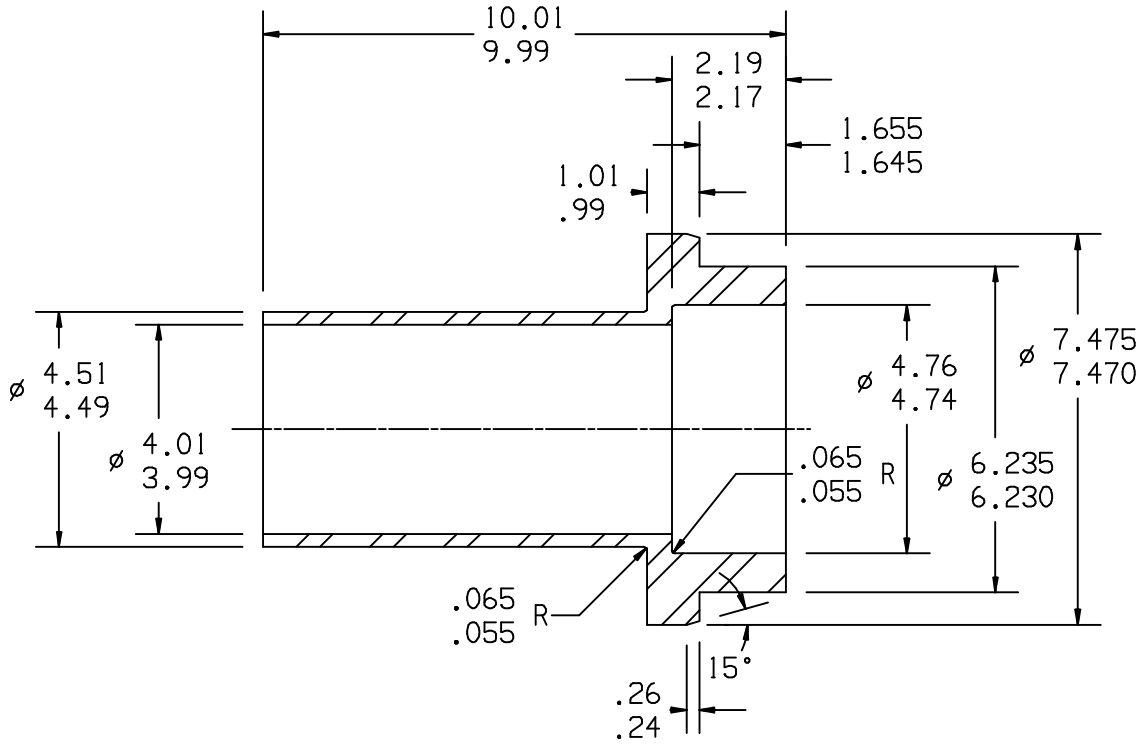
# PD PLUS

## CUTAWAY VIEW - MODEL 1215, 1224, 1230, 1236, 1248; SERIES 66/69

**For Series 19/86 and 55/82, please refer to page 19.**

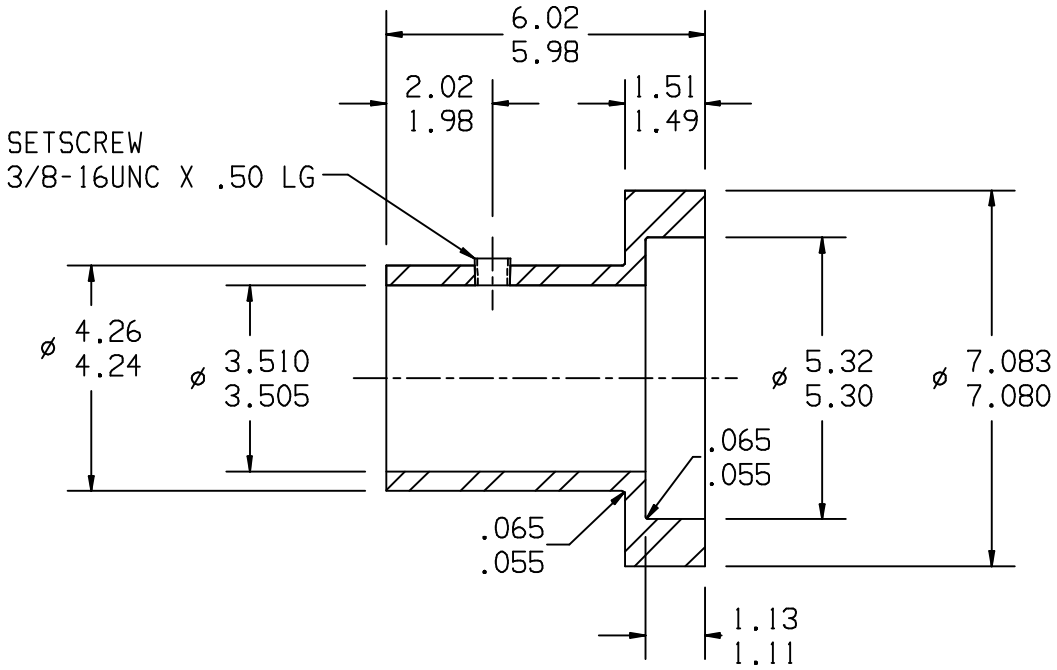


## BEARING & SEAL INSTALLATION TOOL DRAWINGS




Lip Seal Installation Tool

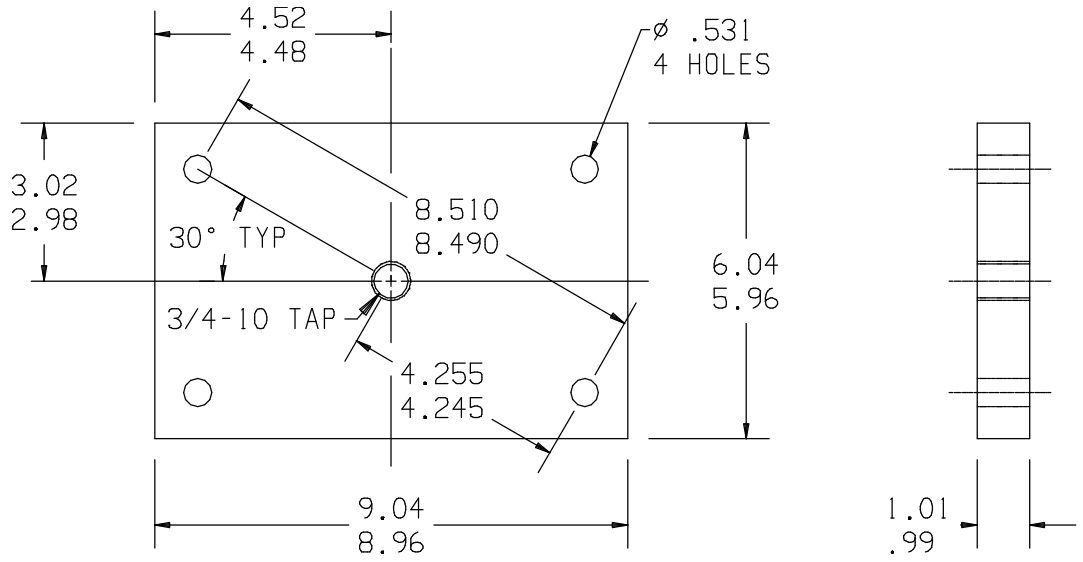
MATERIAL: MILD STEEL




Drive Shaft Bearing Alignment Tool

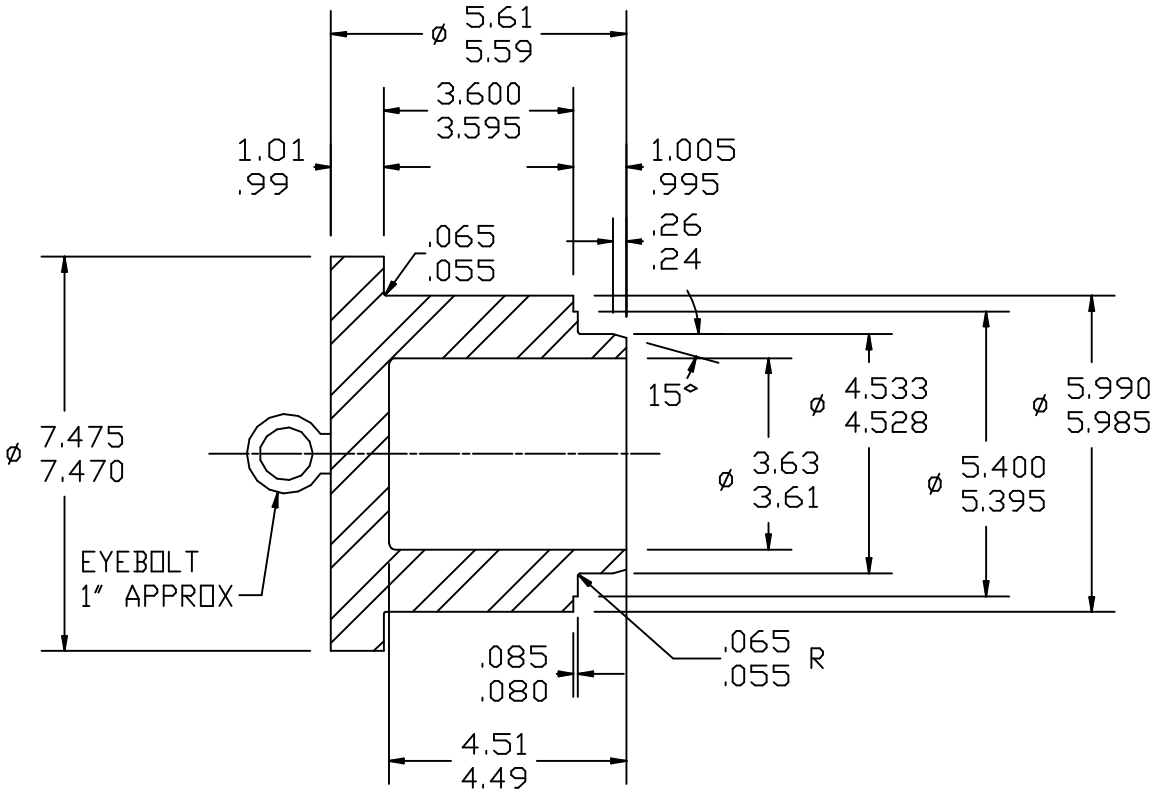
MATERIAL: MILD STEEL

## BEARING & SEAL INSTALLATION TOOL DRAWINGS




Bearing Pressing Fixture

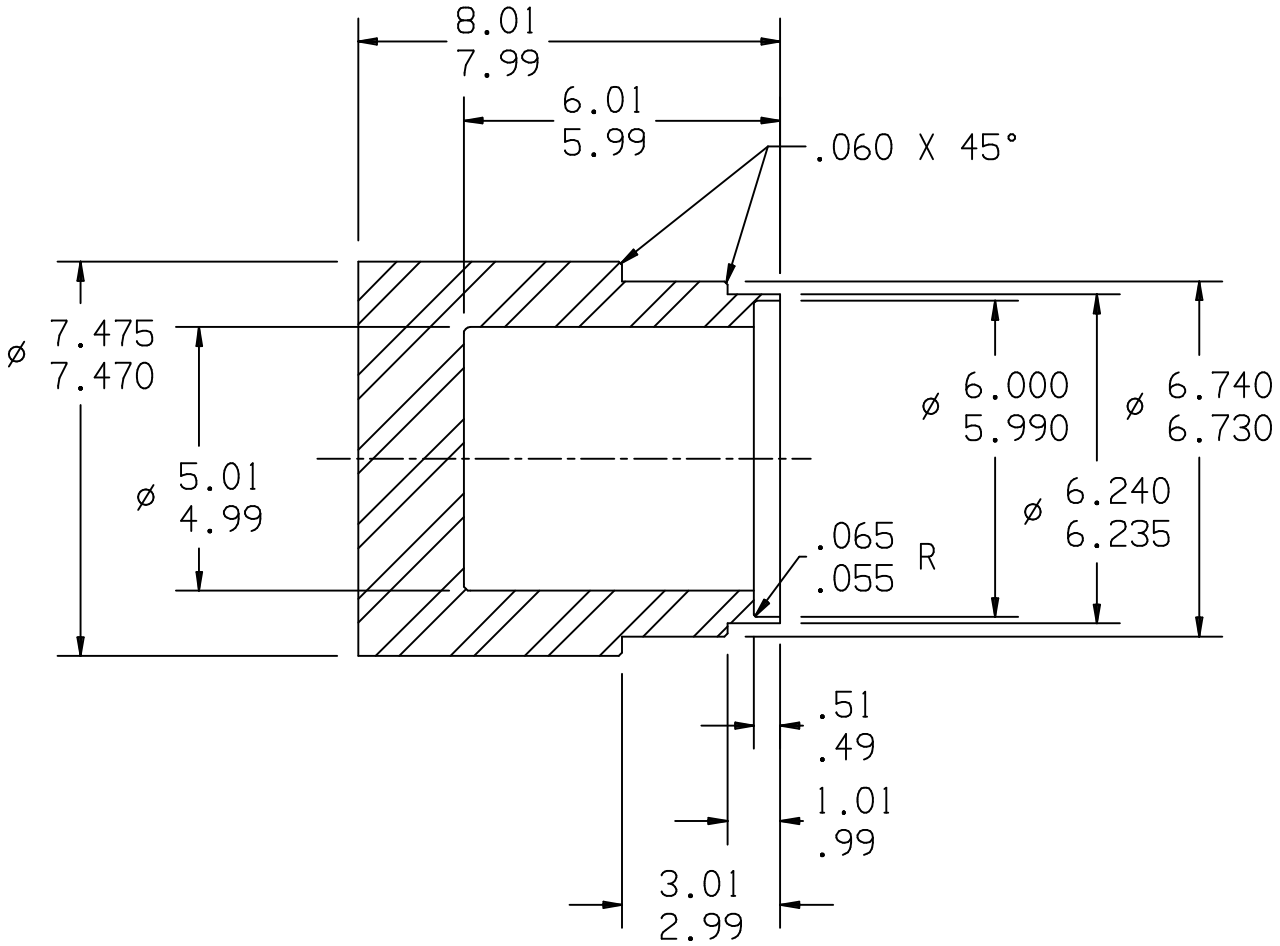
MATERIAL: MILD STEEL



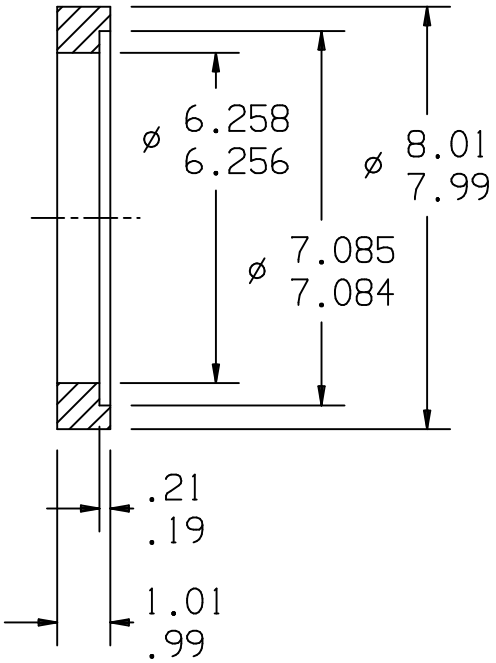

Labyrinth Seal Installation Tool

MATERIAL: MILD STEEL

## BEARING & SEAL INSTALLATION TOOL DRAWINGS




Mechanical Seal Installation Tool (For Press Fit Seals Only) MATERIAL: MILD STEEL




Pilot Tool for Mechanical Seal Installation in Drive Shaft Seal Housing MATERIAL: MILD STEEL

# NOTES

# ***WARRANTY***

Subject to the terms and conditions hereinafter set forth and set forth in General Terms of Sale, Tuthill Vacuum & Blower Systems (the seller) warrants products and parts of its manufacture, when shipped, and its work (including installation and start-up) when performed, will be of good quality and will be free from defects in material and workmanship. This warranty applies only to Seller's equipment, under use and service in accordance with seller's written instructions, recommendations and ratings for installation, operating, maintenance and service of products, for a period as stated in the table below. Because of varying conditions of installation and operation, all guarantees of performance are subject to plus or minus 5% variation. (Non-standard materials are subject to a plus or minus 10% variation)

| **Product Type** | **Type of Application** | |
|---|---|---|
| | **Atmospheric Air or Process Air** | **Process Gases Other Than Air,** |
| New | 24 months from date of shipment, or 18 months after initial startup date, whichever occurs first | 18 months from date of shipment, or 12 months after initial startup date, whichever occurs first |
| Repair | 12 months from date of shipment, or remaining warranty period, whichever is greater | 12 months from date of shipment, or remaining warranty period, whichever is greater |

**THIS WARRANTY EXTENDS ONLY TO BUYER AND/OR ORIGINAL END USER, AND IN NO EVENT SHALL THE SELLER BE LIABLE FOR PROPERTY DAMAGE SUSTAINED BY A PERSON DESIGNATED BY THE LAW OF ANY JURISDICTION AS A THIRD PARTY BENEFICIARY OF THIS WARRANTY OR ANY OTHER WARRANTY HELD TO SURVIVE SELLER'S DISCLAIMER.**

All accessories furnished by Seller but manufactured by others bear only that manufacturer's standard warranty.

All claims for defective products, parts, or work under this warranty must be made in writing immediately upon discovery and, in any event within one (1) year from date of shipment of the applicable item and all claims for defective work must be made in writing immediately upon discovery and in any event within one (1) year from date of completion thereof by Seller. Unless done with prior written consent of Seller, any repairs, alterations or disassembly of Seller's equipment shall void warranty. Installation and transportation costs are not included and defective items must be held for Seller's inspection and returned to Seller's Ex-works point upon request.

**THERE ARE NO WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS OF PURPOSE.**

After Buyer's submission of a claim as provided above and its approval, Seller shall at its option either repair or replace its product, part, or work at the original Ex-works point of shipment, or refund an equitable portion of the purchase price.

The products and parts sold hereunder are not warranted for operation with erosive or corrosive material or those which may lead to build up of material within the product supplied, nor those which are incompatible with the materials of construction. The Buyer shall have no claim whatsoever and no product or part shall be deemed to be defective by reason of failure to resist erosive or corrosive action nor for problems resulting from build-up of material within the unit nor for problems due to incompatibility with the materials of construction.

Any improper use, operation beyond capacity, substitution of parts not approved by Seller, or any alteration or repair by others in such manner as in Seller's judgment affects the product materially and adversely shall void this warranty.

No employee or representative of Seller other than an Officer of the Company is authorized to change this warranty in any way or grant any other warranty. Any such change by an Officer of the Company must be in writing.

The foregoing is Seller's only obligation and Buyer's only remedy for breach of warranty, and except for gross negligence, willful misconduct and remedies permitted under the General Terms of Sale in the sections on **CONTRACT PERFORMANCE, INSPECTION AND ACCEPTANCE** and the **PATENTS** Clause hereof, the foregoing is **BUYER'S ONLY REMEDY HEREUNDER BY WAY OF BREACH OF CONTRACT, TORT OR OTHERWISE, WITHOUT REGARD TO WHETHER ANY DEFECT WAS DISCOVERED OR LATENT AT THE TIME OF DELIVERY OF THE PRODUCT OR WORK.** In no event shall Buyer be entitled to incidental or consequential damages. Any action for breach of this agreement must commence within one (1) year after the cause of action has occurred.

## IMPORTANT

All M-D Pneumatics™ blowers manufactured by Tuthill Vacuum & Blower Systems are date coded at time of shipment. In order to assure you of the full benefits of the product warranty, please complete, tear out and return the product registration card below, or you can visit our product registration web page at http://pneumatics.tuthill.com/product_registration


## IMPORTANT

All M-D Pneumatics™ blowers manufactured by Tuthill Vacuum & Blower Systems are date coded at time of shipment. In order to assure you of the full benefits of the product warranty, please complete, tear out and return this product registration card.


Company _____

Location _____

City State/Province ZIP/Postal Code Country

Telephone: ( ) _____

E-mail: _____

Model: _____

Serial Number: _____

Date of Purchase: _____

Date of Startup: _____

**PLEASE CHECK ONE**

| | |
|---|---|
| Pneumatic Conveying | ☐ |
| Food | ☐ |
| Vacuum | ☐ |
| Paper | ☐ |
| Wastewater | ☐ |
| Gas/Petrochemical | ☐ |
| Other _____ | ☐ |

BY: _____

**NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES**

# BUSINESS REPLY MAIL

FIRST-CLASS MAIL PERMIT NO. 2912 SPRINGFIELD MO

POSTAGE WILL BE PAID BY ADDRESSEE

ATTN CUSTOMER SERVICE
TUTHILL VACUUM & BLOWER SYSTEMS
PO BOX 2877
SPRINGFIELD MO 65890-2150

# Appendix B • Tuthill Blower Long Term Storage Procedures

# LONG TERM STORAGE PROCEDURE

1. During assembly, the following components are to be coated with *preservative:
   A. Lab Seals
   B. Rotors
   C. Endplates (including bores)
   D. Housing (internal)
   E. Ports (internal)

*****(Step 1 does not apply to coated, stainless steel, or oxygen cleaned units)*****

Note: 9000 series lip seal units (-17, -19, -85, -86) are to have double lip seals (single lipped) pre-packed with grease during assembly. These (4) extra seals must be noted on factory order.

2. After assembly and testing, fill end covers with oil to bottom thread of oil fill hole.

3. Metal plugs are to be put in all openings, except port and vent holes.

4. Desiccant bags, P/N 29965, are to be securely attached to port fitting covers.
   A. Threaded ports require the appropriate plastic cover.
   B. Flanged ports require plywood covers installed with silicone sealant, secured with bolts.

5. Driveshaft and key are to be coated with preservative and securely taped with duct tape.

6. Paint per M-D paint specification, except, apply an additional top coat.

7. Add caution tag #30458 to unit.

8. When breathers are required, the breathers are to be wired to the metal plug.

9. The unit is to be completely enclosed in plastic stretch wrap.

10. The unit is then to be created in a solid export plywood box with 2”x 4” reinforcement.

*Preservative: Standard-“Fluid Film”, conforms to Mil-C-16173, Grade 2 corrosion requirement, Mil-C-23411 water displacement.

For applications in food industry-“Haynes” lubrication

## Procedure for Removal from Long Term Storage

1. **Remove port covers (be sure desiccant bags are removed with the covers).**

2. **Remove tape from the drive shaft.**

3. **Drain oil from the unit.**

4. **Refill unit to proper level.**
   - **Center of sight glass on PD Plus units.**
   - **Bottom of plug hole on Competitor units.**
   - **Competitor 21 series grease shaft end before start up.**

**Rev. 6/90**
**Rev. 6/05, ECN 4540**
**Rev. 7/07, ECN 4948, Rev. A**
**Rev. 7/08, ECN 5218, Rev. B**

# Appendix C • Tuthill Technical Bulletin #25
# Instructions for Injecting Fuel Oil, Kerosene and Lube Oil Into Blowers Handling Sewage Gas

TUTHILL CORPORATION | M-D Pneumatics Division

4840 West Kearney Street, P. O. Box 2877
Springfield, Missouri USA 65801-2877
Tel 417 865-8715 800 825-6937 Fax 417 865-2950

# TECHNICAL BULLETIN #25

## Instructions for Injecting Fuel Oil, Kerosene and Lube Oil Into Blowers Handling Sewage Gas

There are many M-D blowers utilized in digester (or sewage) gas applications. Sewage gas is seldom pure, with much dissolved solid matter entrained in the gas stream. When this gas is compressed by the blower and is subsequently heated by the compression process, any moisture is evaporated, allowing the dissolved solids to "plate out" or adhere to the rotors. If enough of these solids (or "sludge") from the digester gas builds up on the rotors, it reduces the blower operating clearances between the rotors, housing and end plates, resulting in equipment failure.

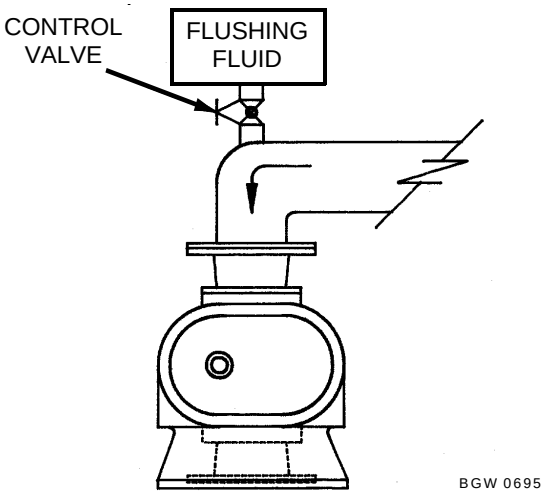
This can be easily prevented by periodically flushing the blower with a mixture of 75% kerosene or fuel oil and 25% lubricating oil. The kerosene or fuel oil dissolves the sludge buildup and the lubricating oil coats the rotors to slow buildup.

The mixture should be injected on the inlet side through a valve set to feed the quantity of the mixture shown in the table below in a period of 15 to 20 minutes. On units regularly flushed, once a week is sufficient. If the unit is dirty, it should be flushed daily until hard buildup is removed and then put on a weekly cycle. In very dirty gas installations the schedule must be varied to meet the demand.

### RECOMMENDATIONS FOR SEWAGE OR DIGESTER GAS BLOWERS

- Always use vertical flow blowers (PD PLUS® -81 or -67 series).
- At least single envelope, mechanically sealed, gastight blowers should be used.
- A corrosion protective coating, such as ARMOLOY®, is highly recommended.
- Two lobe, O-ring plugged rotors should be supplied.
- CTI-9 carbon faces and Kalrez® (or Teflon® coated Viton®) O-rings in the mechanical seals to reduce degradation of mechanical seals from $H_2S$ (hydrogen sulfide) in the sewage gas.
- If discharge temperature is acceptable, operate blowers between 50-70% of maximum design speed.

| MODEL SIZE | FLUSHING QUANTITY GALLONS (LITERS) |
|---|---|
| 3200 | 0.5 (2.0) |
| 4000 | 1.0 (4.0) |
| 5500 | 1.0 (4.0) |
| 7000 | 1.5 (6.0) |
| 9000 | 2.0 (8.0) |
| 1200 | 3.0 (12.0) |



# Appendix D • Tuthill Technical Bulletin #4
# Recommended Lubricants for Tuthill M-D Pneumatics Rotary Blowers and Vacuum Boosters

TUTHILL
Vacuum & Blower Systems

4840 West Kearney Street, P.O. Box 2877
Springfield, Missouri USA 65801-2877
Tel 417 865-8715 800 825-6937 Fax 417 865-2950

# TECHNICAL BULLETIN #4

## Recommended Lubricants for Tuthill M-D Pneumatics™ Rotary Blowers and Vacuum Boosters

### RECOMMENDED MINERAL BASED LUBRICANTS FOR ROTARY BLOWERS

| AMBIENT TEMPERATURE | SHELL | CITGO | CHEVRON TEXACO | EXXONMOBIL |
|---|---|---|---|---|
| **0° F (-18° C) to 32° F (0° C)** | TELLUS® PLUS 68 (ISO 68) | A/W 68 (ISO 68) | RANDO HD 68 (ISO 68) | DTE HEAVY MEDIUM (ISO 68) |
| **32° F (0° C) to 90° F (32° C)** | TELLUS® PLUS 100 (ISO 100) | A/W 100 (ISO 100) | RANDO HD 100 (ISO 100) | DTE HEAVY (ISO 100) |
| **90° F (32° C) to 120° F (50° C)** | TELLUS® PLUS 150 (ISO 150) | A/W 150 (ISO 150) | RANDO HD 150 (ISO 150) | DTE EXTRA HEAVY (ISO 150) |

### RECOMMENDED SYNTHETIC BASED LUBRICANTS FOR ROTARY BLOWERS *

| AMBIENT TEMPERATURE | TUTHILL | EXXONMOBIL | SHELL |
|---|---|---|---|
| **0° F (-18° C) to 32° F (0° C)** | **PneuLube™** (ISO 100) | SHC 626 (ISO 68) | MADRELA® AS 68 (ISO 68) |
| **32° F (0° C) to 90° F (32° C)** | | SHC 627 (ISO 100) | MADRELA® P 100 (ISO 100) |
| **90° F (32° C) to 120° F (50° C)** | | SHC 629 (ISO 150) | MADRELA® P 150 (ISO 150) |

**NOTE:** Tuthill Vacuum & Blower Systems cannot accept responsibility for damage to seals, O-rings and gaskets caused by use of synthetic lubricants not recommended by Tuthill Vacuum & Blower Systems.

* Blowers used in oxygen-enriched service should use **only** Castrol Brayco 1726 Plus non-flammable, PFPE synthetic lubricant.

Blowers used in hydrogen service should use only **PneuLube** synthetic oil.

### RECOMMENDED MINERAL BASED, FOOD GRADE LUBRICANTS FOR ROTARY BLOWERS

| AMBIENT TEMPERATURE | Lubricant meeting U.S. FDA regulations 21 CFR 172.878 and 178.3620(a) for direct and indirect food contact | Lubricant meeting U. S. FDA regulation 21 CFR 178.3570 governing petroleum products which may have incidental contact with food (formerly USDA H1 requirements) |
|---|---|---|
| **0° F (-18° C) to 32° F (0° C)** | CITGO CLARION® 350 FOOD GRADE (ISO 68) | CITGO CLARION® A/W 68 (ISO 68) |
| **32° F (0° C) to 90° F (32° C)** | CONSULT FACTORY | CITGO CLARION® A/W 100 (ISO 100) |
| **90° F (32° C) to 120° F (50° C)** | CONSULT FACTORY | CONSULT FACTORY |

### RECOMMENDED LUBRICANTS FOR VACUUM BOOSTERS (ALL 90 THROUGH 96 SERIES AND 31 THROUGH 37 SERIES)

**REQUIREMENTS:**

- Suitable for high vacuum service
- 68-100 cSt @ 40° C (104° F )
- Vapor pressure of 1 micron or less @ 21° C (70° F )
- Straight mineral (no additives) or PAO synthetic oil

**TYPICAL LUBRICANTS:**

**Tuthill: PneuLube (synthetic)**
**Mobil:** DTE 16 (mineral based)
**Shell:** Turbo 68 (mineral based)
**Sunoco:** Sunvis 31 (mineral based)

### RECOMMENDED GREASE FOR COMPETITOR® PLUS BLOWERS:

Tuthill **PneuLube™** NLGI #2 premium grade, petroleum base lithium grease.

For food grade requirements, use Citgo Clarion® Food Grade HTEP grease, NLGI No. 2 grade. It meets all requirements of FDA Regulation 21 CFR 178.3570 (the former USDA H-1 approval requirements) for lubricants having incidental contact with food.

# Appendix E • Gardner Denver
# Parts List, Operating and Service Manual
# Blowers/Vacuum Pumps, 11CDL - P Series

GARDNER DENVER

Experience Proven Results™

# PARTS LIST OPERATING AND SERVICE MANUAL

## BLOWERS/VACUUM PUMPS

### 11CDL – P SERIES


ENERGY STAR PARTNER

**37-1-616**
**Version 03**
**November 1, 2010**

**MAINTAIN BLOWER RELIABILITY AND PERFORMANCE WITH GENUINE GARDNER DENVER PARTS AND SUPPORT SERVICES**

Factory genuine parts, manufactured to design tolerances, are developed for optimum dependability - - - specifically for your blower. Design and material innovations are born from years of experience with hundreds of different blower applications. When you specify factory genuine parts you are assured of receiving parts that incorporate the most current design advancements . . .manufactured in our state-of-the-art blower factory under exacting quality standards.

Your AUTHORIZED DISTRIBUTOR offers all the backup you require. A worldwide network of authorized distributors provides the finest product support in the blower industry.

1. Trained parts technical representatives to assist you in selecting the correct replacement parts.

2. Complete inventory of new machines and new, genuine factory parts.

3. A full line of factory tested AEON™ PD blower lubricants specifically formulated for optimum performance in all blowers.

4. Authorized distributor service technicians are factory-trained and skilled in blower maintenance and repair. They are ready to respond and assist you by providing fast, expert maintenance and repair service.

INSTRUCTIONS FOR ORDERING REPAIR PARTS

For pricing and ordering information contact your nearest AUTHORIZED FACTORY DISTRIBUTOR. When ordering parts, specify Blower MODEL and SERIAL NUMBER (see nameplate on unit).

Use this Parts List to select the parts you require. Where NOT specified, quantity of parts required per blower is one (1); where more than one is required per unit, quantity is indicated.

Rely upon the knowledge and experience of you AUTHORIZED DISTRIBUTOR and let them assist you in making the proper parts selection for you blower.

**For the location of your local authorized Gardner Denver blower distributor refer to the yellow pages of your phone directory, check the Web site at www.gardnerdenver.com or contact:**

Gardner Denver Compressor Division
1800 Gardner Expressway
Quincy, IL 62305
Phone: (217) 222-5400
Fax: (217) 221-8780

## GARDNER DENVER LUBRICANT ORDER INFORMATION

Re-order Part Numbers for Factory-Recommended Lubricants.

AEON PD Synthetic Lubricant or AEON PD-Food Grade Synthetic Lubricant

### AEON PD Synthetic Lubricant

| Description | Part Number |
|---|---|
| 1 Quart | 28G23 |
| Case/ 12 Quarts | 28G24 |
| 5 Gallon Pail | 28G25 |
| 55 Gallon Drum | 28G28 |

### AEON PD-Food Grade Synthetic Lubricant

| Description | Part Number |
|---|---|
| 1 Quart | 28H97 |
| Case/ 12 Quarts | 28H98 |
| 5 Gallon Pail | 28H99 |
| 55 Gallon Drum | 28H100 |

### AEON PD - XD Synthetic Lubricant

| Description | Part Number |
|---|---|
| 1 Quart | 28G46 |
| Case/ 12 Quarts | 28G47 |
| 5 Gallon Pail | 28G44 |
| 55 Gallon Drum | 28G45 |

Call your local CycloBlower® Distributor to place your order for Gardner Denver Lubricants. Your Authorized Gardner Denver Distributor is:

**FOREWORD**

CycloBlower® blowers are the result of advanced engineering and skilled manufacturing. To be assured of receiving maximum service from this machine, the owner must exercise care in its operation and maintenance. This book is written to give the operator and maintenance department essential information for day-to-day operation, maintenance and adjustment. Careful adherence to these instructions will result in economical operation and minimum downtime.

| ⚠ DANGER |
| --- |
| **Danger is used to indicate the presence of a hazard which will cause severe personal injury, death, or substantial property damage if the warning is ignored.** |

| ⚠ WARNING |
| --- |
| **Warning is used to indicate the presence of a hazard which can cause severe personal injury, death, or substantial property damage if the warning is ignored.** |

| ⚠ CAUTION |
| --- |
| **Caution is used to indicate the presence of a hazard which will or can cause minor personal injury or property damage if the warning is ignored.** |

| NOTICE |
| --- |
| **Notice is used to notify people of installation, operation or maintenance information which is important but not hazard-related.** |

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## SAFETY PRECAUTIONS

Safety is everybody's business and is based on your use of good common sense. All situations or circumstances cannot always be predicted and covered by established rules. Therefore, use your past experience, watch out for safety hazards and be cautious. Some general safety precautions are given below:

**⚠ DANGER**

**Failure to observe these notices could result in injury to or death of personnel.**

- **Keep fingers and clothing away from blower inlet and discharge ports, revolving belts, sheaves, drive coupling, etc.**
- **Do not use the air discharge from this unit for breathing – not suitable for human consumption.**
- **Do not loosen or remove the oil filler plug, drain plugs, covers or break any connections, etc., in the blower air or oil system until the unit is shut down and the air pressure has been relieved.**
- **Electrical shock can and may be fatal.**
- **Blower unit must be grounded in accordance with the National Electrical Code. A ground jumper equal to the size of the equipment ground conductor must be used to connect the blower motor base to the unit base.**
- **Open main disconnect switch, tag and lockout before working on the control.**
- **Disconnect the blower from its power source, tag and lockout before working on the unit – this machine is automatically controlled and may start at any time.**

**⚠ WARNING**

**Failure to observe these notices could result in damage to equipment.**

- **Stop the unit if any repairs or adjustments on or around the blower are required.**
- **Disconnect the blower from its power source, tag and lockout before working on the unit – this machine is automatically controlled and may start at any time.**
- **Do not exceed the rated maximum speed value shown on the nameplate.**
- **Do not operate unit if safety devices are not operating properly. Check periodically. Never bypass safety devices.**

## INTRODUCTION
## YOUR KEY TO TROUBLE FREE SERVICE

Although Gardner Denver blowers are sturdy, precision-engineered machines, there are several relatively simple but basic installation and maintenance procedures that must be observed to assure optimum performance. As there is no guesswork in the manufacture of these highly advanced units, there must be none in preparing them to get the job done in the field.

It is the purpose of this manual to help you properly install, maintain and service your Gardner Denver blower. It is important that no section be overlooked when preparing to install your blower.

Follow the instructions carefully and you will be rewarded with years of trouble-free operation.

## SECTION 1
## EQUIPMENT CHECK

Before uncrating, check the packing slip carefully to be sure all the parts have been received. All accessories are listed as separate items on the packing slip, and small important accessories such as relief valves can be overlooked or lost. After every item on the packing slip has been checked off, uncrate carefully. Register a claim with the carrier for lost or damaged equipment.

**⚠WARNING**

**Customers are cautioned to provide adequate protection, warning and safety equipment necessary to protect personnel against hazards involved in installation and operation of this equipment in the system or facility.**

### STORAGE

Your Gardner Denver Blower was packaged at the factory with adequate protection to permit normal storage for up to six (6) months.

If the unit is to be stored under adverse conditions or for extended periods of time, the following additional measures should be taken to prevent damage.

1. Store the blower in a clean, dry, heated (if possible) area.
2. Make certain inlet and discharge air ports are tightly covered to prevent foreign material from entering the air box.
3. All exposed, non-painted surfaces should be protected against rust and corrosion.
4. Provide adequate protection to avoid accidental mechanical damage.
5. In high humidity or corrosive environments, additional measures may be required to prevent rusting of the blower internal surfaces.
6. To prevent rusting of gears, bearings, etc., the oil reservoirs may be filled with normal operating oil.

**⚠CAUTION**

**Before running the blower, drain the oil and replace to the proper operating level with clean, fresh lubricant.**

7. Rotate the blower shaft (10 to 25 turns) monthly during storage. Inspect the blower shaft (near the shaft seal area) monthly and spray with rust inhibitor if needed.
8. For long term storage (over six (6) months), contact Gardner Denver Customer Service for recommendations.

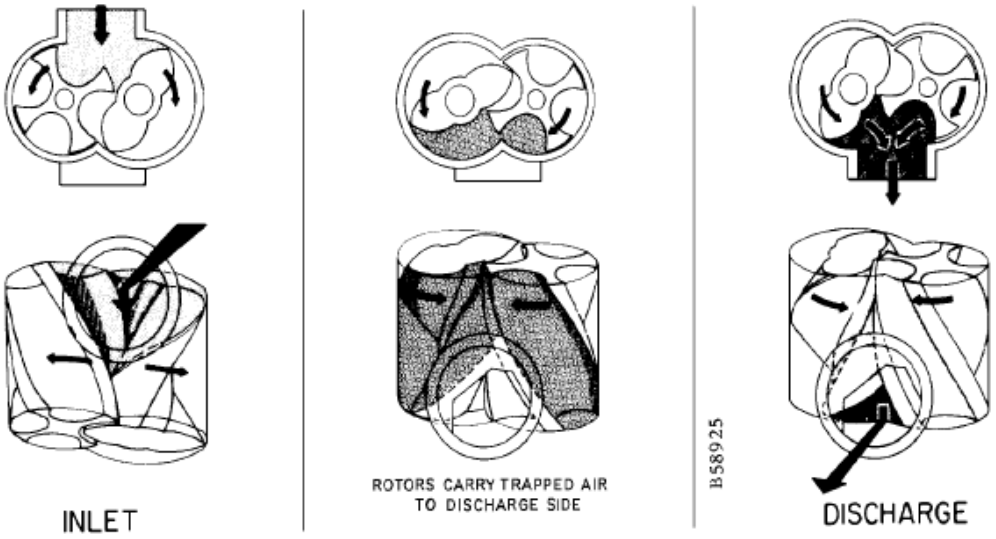



**FIGURE 2-1 – OPERATING PRINCIPLE**

**GENERAL** – The CycloBlower® is a compact, rotary lobe type axial flow blower. The meshing of two screw type rotors synchronized by timing gears provides controlled compression of the air for maximum efficiency and pulsation free discharge.

**OPERATING PRINCIPLE** – Compression is effected by the main (2 lobe) and gate (4 flute) rotors meshing enclosed in the housing. The timing gears maintain close rotor clearances. The rotors do not touch each other, the housing, or the bearing carriers. Although clearances are small, lubrication in the compression chamber is not required, insuring oil-free air delivery.

The compression cycle (FIGURE 2-1) begins as the rotors unmesh at the inlet port. Air is drawing into the rotor cavities, trapped, and compressed by the reducing cavities as rotation continues. When proper compression is made, the cavities cross the discharge port, completing the cycle. The cycle occurs twice each revolution of the main bearing rotor and is continuous.

**CONSTRUCTION** – All models of the 11CDL Series CycloBlower® are of similar design and construction except for rotor length. The housing is a one-piece casting with flanged inlet and discharge openings.

The rotors are ductile iron with integral cast shaft. Rotors are dynamically balanced for vibration-free operation. Helical timing gears are of alloy steel, hobbed and shaved for quiet operation.

Two heavy-duty angular-contact ball bearings are used on each rotor shaft, at the discharge end, as fixed bearings to maintain rotor end clearance.

A radial bearing is used on each rotor shaft at the gear end as a floating bearing.

All gears and bearings are oil splash lubricated.

Standard construction is top inlet, bottom discharge, with drive shaft extension from main rotor at the discharge end. Rotation is clockwise facing the drive shaft. Blowers may be mounted for either V-belt or direct-coupled drive. The gate rotor speed is half (1/2) the main rotor or drive speed.

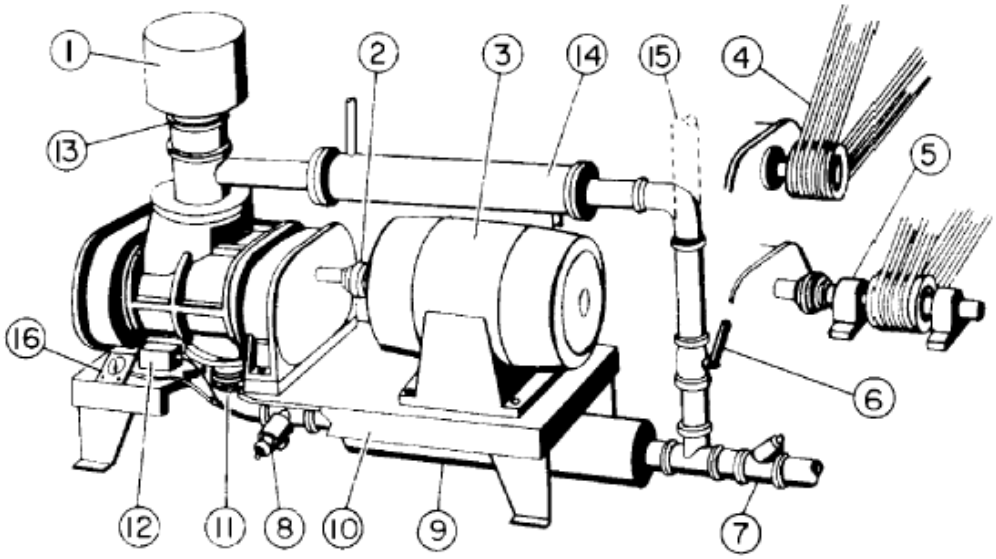



**FIGURE 2-2 – ACCESSORIES AND SAFETY DEVICES**

**LOCATION –** Select a clean, dry, well-ventilated area for installing blower and allow ample room for normal maintenance. Proper ventilation is necessary for blower cooling and cool air intake.

**⚠WARNING**

**Do not electric weld on the blower or base; bearings can be damaged by the passage of current.**

**FOUNDATIONS –** Correct supporting is important. Distortion by incorrect supporting will affect internal operating clearances. The foundation or base must provide a level, rigid, nonworking support for the blower. It must be on uniform and solid footing. Complete foundation design cannot be given because of varying conditions. If necessary, use shims under feet for leveling to prevent distortion when foundation bolts are tightened. After installation on the foundation is complete, check alignment of the coupling or drive before starting blower.

**ACCESSORIES** (FIGURE 2-2) – The type of service determines the accessory group required. The typical items are listed as follows:

1. Inlet Filter or Filter-silencer.
2. Flexible Coupling
3. Driver.
4. Simple V-Belt Drive.
5. Jackshaft V-Belt Drive.
6. Bypass Valve.
7. Check Valve.
8. Relief Valve, Vacuum or Pressure.
9. Discharge Silencer.
10. Base Plate.
11. Expansion Joint(s) – Inlet and/or Discharge.
12. Temperature or Pressure Shutdown Switch.
13. Check Valve (Inlet Bypass).
14. Heat Exchanger.
15. Bypass to atmosphere (alternate).
16. Pressure Gauge or Vacuum Gauge.

**Inlet Filter or Filter-Silencer** – For pressure service handling air, the blower inlet must be protected by a filter of suitable size to allow full flow of air to the blower inlet. The filter must be of adequate efficiency to trap any foreign materials which may be in the general area of the air inlet. If noise is a factor, filter-silencers are available.

**⚠WARNING**

**Rotating components will cause severe injury in case of personal contact. Keep hands away from the blower inlet and discharge ports.**

In choosing a location for the filter, consideration should be given to a source of cool, clean air, and most important, access for maintenance.

Filters generally used for blower service fall under three types:

Oil-wetted Screen Type

Oil Bath

Dry Type

Filter-silencers are also available in the above types.

For vacuum service, the type of system used and materials being handled will determine the necessity for an in-line filter.

**Couplings** – For direct-coupled units, a flexible type coupling, accurately aligned, should be used between the blower and power unit. A grid type coupling is recommended. Misaligned couplings may cause vibration, additional bearing loads and stresses which will affect life of parts involved. DO NOT drive the couplings on shaft. Check shaft and coupling bore for burrs. Polish the shaft and bore if necessary for proper fit. Fit keys to keyways. Check coupling alignment. Exact alignment will vary with the type of couplings; however, it is not uncommon to hold alignment within .003" in all directions. With lubricated or special couplings, follow the manufacturer's instructions for installation and maintenance. Do not use couplings that may cause an axial thrust during operation.

**DRIVE INSTALLATION**

**V-Belt Drive** – Follow normal specifications recommended by the belt manufacturers for installation of belt drive on blowers. To provide the most compact drive, it is suggested that high capacity V-belt drives be used. Blower shaft and power unit shaft should be parallel, with sheaves aligned on shafts so belts run true. Use only matched belt sets and replace belts in complete sets only. Belt tension should be according to manufacturer's recommendations. Slippage can be detected by belt squeal, overheating or loss of speed. A few hours after initial starting with new belts, it is advisable to recheck belt tension and provide tension adjustment as necessary.

**⚠WARNING**

**Over tightening belts leads to heavy bearing loads and premature failure.**

When selecting a V-belt drive, check to be sure the maximum allowable moment limitation is not exceeded. Refer to (Figure 2-3 page 14), for V-belt drive overhung load calculations. (Figure 2-3), applies to V-belt calculations only. Exceeding overhung load limitations leads to premature bearing failure and potential shaft breakage.

## NOTICE

**When a simple V-belt drive is not available, to stay within the maximum allowable moment, a jackshaft V-belt drive is required.**

Belt drives must be carefully aligned. Motor and blower pulleys must be parallel to each other and in the same plane within 1/16 inch. Belt tension should be carefully adjusted and belts tightened only enough to prevent slippage.

## NOTICE

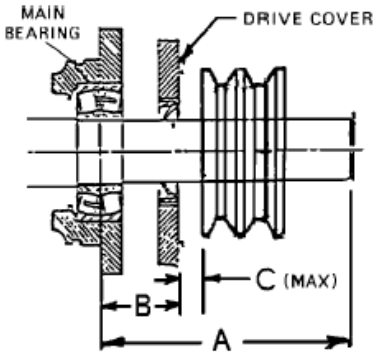
**The sheave should be positioned as close as possible to the drive cover. This will reduce the overhung load and extend the bearing life.**

On direct connected units, alignment and lubrication of the couplings to specifications of the coupling manufacturer are very important. When mounted drives are supplied from the factory, proper alignment has been established before shipment. However, during shipping, handling and installation, it is likely that the alignment has been disturbed and final adjustment must be made before startup.

**Synchronous-Belt Drive** – Synchronous belts are not recommended for usage on Gardner Denver positive displacement blowers. Installation of synchronous belts is critical and can result in alignment, tensioning and vibration problems, which contribute to higher than normal loads and stresses on the blowers.

| 11CDL Drive Shaft Location | Dimensions (Inches) | | | Maximum Allowable Moment (LB-IN) |
|---|---|---|---|---|
| | A | B | C (Max) | |
| Discharge End (Standard) | 12.70 | 5.05 | 0.5 | 21,395 |
| Gear End (Optional) | 14.65 | 6.87 | 0.5 | 21,395 |

**MAXIMUM ALLOWABLE MOMENT**




**DRIVE SHAFT ILLUSTRATION**

| Z | Ac | Z | Ac | Z | Ac | Z | Ac | Z | Ac | Z | Ac |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.000 | 1.000 | 0.250 | 0.966 | 0.500 | 0.926 | 0.750 | 0.879 | 1.000 | 0.823 | 1.250 | 0.751 |
| 0.025 | 0.997 | 0.275 | 0.962 | 0.525 | 0.922 | 0.775 | 0.874 | 1.025 | 0.816 | 1.275 | 0.742 |
| 0.050 | 0.994 | 0.300 | 0.958 | 0.550 | 0.917 | 0.800 | 0.869 | 1.050 | 0.810 | 1.300 | 0.734 |
| 0.075 | 0.990 | 0.325 | 0.954 | 0.575 | 0.913 | 0.825 | 0.864 | 1.075 | 0.803 | 1.325 | 0.725 |
| 0.100 | 0.987 | 0.350 | 0.951 | 0.600 | 0.908 | 0.850 | 0.858 | 1.100 | 0.796 | 1.350 | 0.716 |
| 0.125 | 0.983 | 0.375 | 0.947 | 0.625 | 0.904 | 0.875 | 0.852 | 1.125 | 0.789 | 1.375 | 0.706 |
| 0.150 | 0.980 | 0.400 | 0.943 | 0.650 | 0.899 | 0.900 | 0.847 | 1.150 | 0.782 | 1.400 | 0.697 |
| 0.175 | 0.977 | 0.425 | 0.939 | 0.675 | 0.894 | 0.925 | 0.841 | 1.175 | 0.774 | 1.425 | 0.687 |
| 0.200 | 0.973 | 0.450 | 0.935 | 0.700 | 0.889 | 0.950 | 0.835 | 1.200 | 0.767 | | |
| 0.225 | 0.969 | 0.475 | 0.930 | 0.725 | 0.884 | 0.975 | 0.829 | 1.225 | 0.759 | | |

**ARC OF CONTACT FACTORS**

$$\text{Belt Pull} = \left[\frac{2.5 - Ac}{Ac}\right] \left[\frac{125954 \times Hp \times S.F.}{D \times RPM}\right]$$

Key:
- Ac = Arc of Contact Factor (Refer to Arc of Contact Factor Chart above)
- Hp = Blower Horsepower for Operating Conditions
- S.F. = Drive Servce Factor (use 1.4 S.F. for continuous duty applications)
- D = Blower Sheave Pitch Diameter in Inches
- RPM = Blower Sheave Speed
- Z = $\frac{\text{Large Sheave Pitch Diameter (in)} - \text{Small Sheave Pitch Diameter (in)}}{\text{Sheave Center Distance (in)}}$

**CALCULATION OF BELT PULL**

$$\text{Shaft Moment (LB-IN)} = \text{Belt Pull} \times \left[B + C + \left(\frac{\text{Sheave Width}}{2}\right)\right]$$

**CALCULATION OF SHAFT MOMENT**

**FIGURE 2-3 – V-BELT DRIVE OVERHUNG LOAD CALCULATIONS**

**Bypass Valve** – Installation of a bypass valve at the blower discharge (FIGURE 2-2, page 11) will allow the blower to be started under no-load. Bypass line may be discharged at atmosphere or to blower inlet depending on local requirements or material being handled.

**Heat Exchanger** – When the bypass line discharges to blower inlet, a heat exchanger must be included in the line between blower discharge and blower inlet, to remove the heat of compression before the gas is reintroduced into the blower inlet. A check valve (FIGURE 2-2, page 11) should also be placed in the inlet line between the bypass line and the inlet filter or silencer, to prevent discharging backwards through the filter or silencer.

**SAFETY DEVICES –** For all installations the following safety devices are a requirement for safe blower operation. Numbers shown are reference numbers used in (FIGURE 2-2, page 11).

7. Check Valve, Blower Discharge Line
8. Relief Valve, Vacuum or Pressure
12. High Discharge Air Temperature Switch

**Check Valve** (FIGURE 2-2, page11) – When the blower is used in a pneumatic conveying system, a check valve must be used to prevent backflow of material into the blower. In any system it is a safety device preventing the down stream pressure from motoring the blower through shutdown periods. A check valve must be provided for each blower when several blowers are manifold into a common system.

**Relief Valve** (FIGURE 2-2, page11) –The relief valve must be installed as close to blower ports as possible. There should be no accessories such as valves, check valves, silencers, etc. between the relief valve and blower ports. It should be set 2 to 3 PSI above blower operating pressure (1/2" to 1" Hg. In vacuum service).

## NOTICE

**Relief valves should be placed as close as possible to the blower inlet port (vacuum operation) or discharge port (pressure operation).**

**High Temperature and High Pressure Shutdown** – All blower installations should be protected with a high temperature shutdown switch. The controls should be set to stop the blower when the discharge temperature reaches 355° F. In some installations a high pressure shutdown switch may also be advisable. The sensing element of these controls should be installed as close to the blower discharge as possible. See (FIGURE 2-2, page 11). On remote or unattended installations these controls are normally mandatory.

**INLET PIPING** – During the installation of piping make sure dirt and other foreign materials do not enter blower openings. When inlet piping is used IT MUST BE CLEAN, AND FREE OF SCALE AND OTHER FOREIGN MATERIALS WHICH COULD ENTER THE BLOWER. It is suggested that an expansion joint be installed near blower openings to prevent stressing of the blower housing. Support the pipe to relieve weight on the expansion joint and the blower. Make sure the pipe size is adequate and as straight as possible to prevent pressure drop at the blower inlet. Where bends are necessary use long radius fittings. All connections must be air tight.

For vacuum service, an accurate vacuum gauge must be used near the blower inlet to indicate operating vacuum and a suitable vacuum relief valve must be used. A vacuum blower in pneumatic conveying service requires pre-inlet separation and filtering to prevent material carry-over into the blower.

Estimated Inlet pipe size is determined as follows:

0 to 10 feet long, use pipe size equal to blower inlet flange size.

10 to 17 feet long, use pipe size larger than blower inlet.

17 to 33 feet long, two pipe sizes larger than blower inlet.

**DISCHARGE PIPING** – In general, the type of system used will govern the piping arrangement. However, the following suggestions should be followed for blower protection and efficiency.

An expansion joint should be installed as close to the blower opening as possible to protect the blower housing from stresses. All pipe connections should be square and even to prevent distortion from misalignment.

An accurate pressure gauge must be provided near the blower discharge to indicate operation pressure. If noise level is a factor, a discharge silencer should be used. The discharge line should be as straight as possible. Where bends are necessary, use long radius fittings. Provision for condensate drainage at the lowest point in the piping may be required.

**VENTILATION –** If the blower is to operate in a housing or enclosure, proper ventilation must be provided for adequate blower cooling. Cooling air should be taken from outside the enclosure.

**OUTLINE DRAWINGS** – Certified outline drawings are available upon request. All important dimensions are shown in Figure 2-4 & Figure 2-5, page 17 & 18.

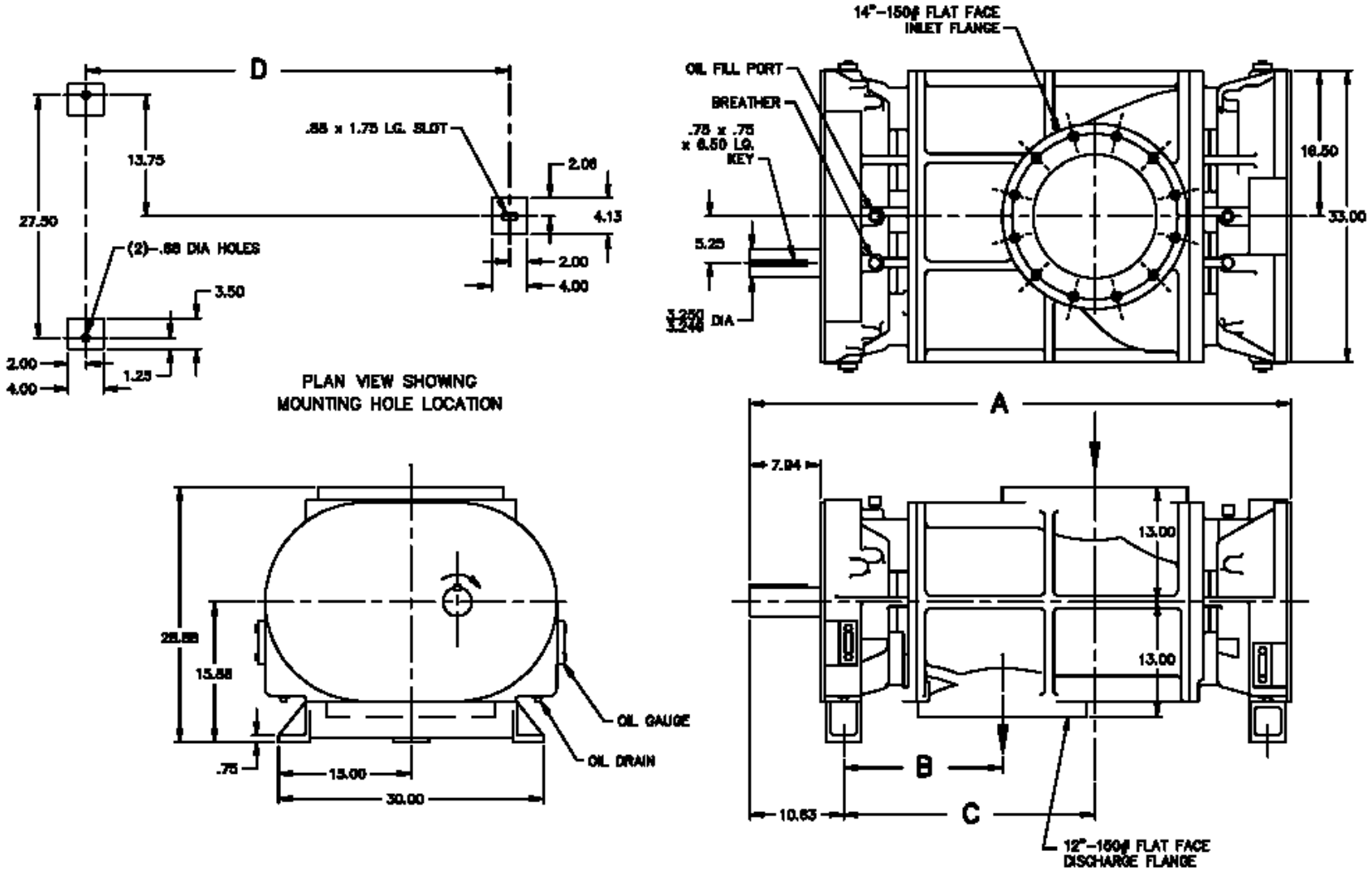



FIGURE 2-4 – OUTLINE DIMENSIONS

**TOP INLET, MAIN ROTOR DRIVE**

| MODEL | WT. (lbs.) | A (Inches) | B (Inches) | C (Inches) | D (Inches) | OUTLINE DIMENSIONS DRAWING NO. |
|---|---|---|---|---|---|---|
| 11CDL23P | 3175 | 53.38 | 19.56 | 22.00 | 40 | 203CBT800 |
| 11CDL27P | 3420 | 57.25 | 20.00 | 22.44 | 44 | 202CBT800 |
| 11CDL31P | 3585 | 61.25 | 18.00 | 28.44 | 48 | 300CBT800 |

**FIGURE 2-5 – OUTLINE DIMENSIONS (CONTINUED)**

## SECTION 3
## OPERATION

Future operating problems can be avoided if proper precautions are observed when the equipment is first put into service.

Before starting under power, the blower should be turned over by hand to make certain there is no binding or internal contact.

Each size blower has limits on pressure differential, running speed, and discharge temperature which must not be exceeded. These limits are shown in the following tables and text in section 3.

**GENERAL** – A new blower from the factory must be checked and serviced before operation. The blower must be lubricated and operated according to the following instructions. Blower failure can be caused by operation at above rated pressure or below rated minimum speed. Both cause excessive discharge temperature and seizure of rotating parts.

**STARTING BLOWER** – Start at reduced speed and no-load if possible. If speed is fixed, start without load by bleeding discharge to atmosphere. Starting should be smooth and free of vibrations. After initial no-load start, and operation is satisfactory, apply load gradually until maximum operating conditions are attained. BE SURE OPERATING CONDITIONS ARE WITHIN BLOWER RATINGS. Maintain a close check for severe vibrations, unusual noise, leaks and undue heating. The blower will gradually heat up due to compression, but after a reasonable length of time, temperature will stabilize. With very cold ambient conditions, warm up blower at no-load before going into full load service.

If the blower is used as part of a specific system, check the system's manual for any procedures that may be necessary when starting the blower.

**PRESTART CHECK** (For New or Overhauled Blower) – see "Blower Startup Checklist," page 24.

**ROTATION** – Facing the main rotor drive shaft, rotation is clockwise when the shaft extension is at discharge end, and counterclockwise when the shaft extension is at the inlet end. An arrow indicating rotation is attached to the blower end cover near the drive shaft.

**DAILY CHECK**

1. Air filter tight, clean and serviced.
2. Proper oil level in oil sumps.
3. Observe pressure.
4. Relief valve functions.
5. Blower turns freely.

**⚠WARNING**

**Operating beyond the specified operating limitations will result in damage to the unit.**

| P Series Models | Drive Shaft Speed (RPM) | Discharge Pressure* Sea Level (PSIG) | Dry Vacuum* (Inches Hg) | Wet Vacuum* (Inches Hg) |
|---|---|---|---|---|
| 11CDL23, 11CDL27, 11CDL31 | 2200 | 20 | 17 | ---- |
| 11CDL23, 11CDL27, 11CDL31 | 2000 | ---- | ---- | 24 |

* Pressures or vacuums are gauged at immediate blower discharge or inlet. For suggested maximum ratings at reduced speeds, See (FIGURE 3-6, page 23).

**FIGURE 3-1 – MAXIMUM RATING**

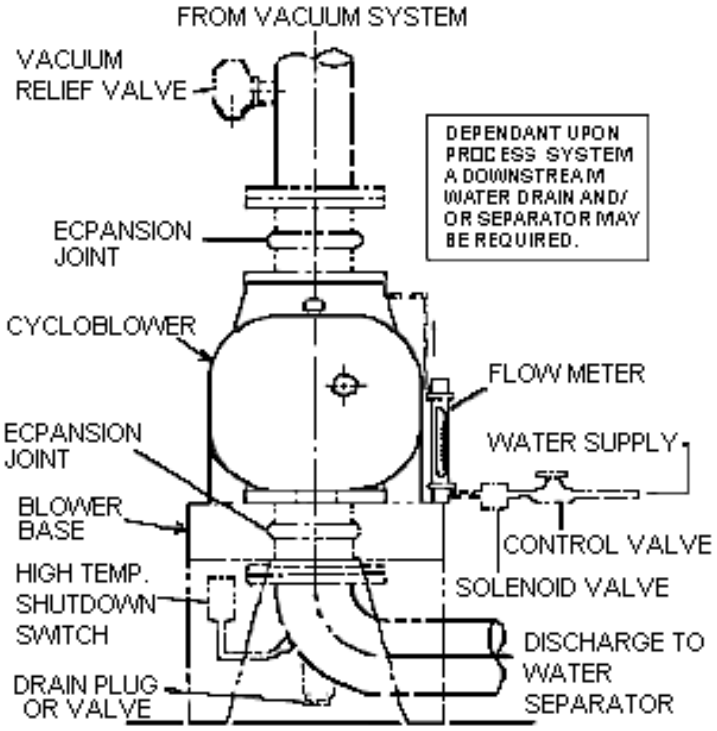



**FIGURE 3-2– INLET WATER INJECTION DIAGRAM**

**TYPE OF SERVICE** – The blower can be operated in either pressure or vacuum service.

**Pressure** – Never operate the blower above the maximum pressure shown in FIGURE 3-1, page 19. Excessive pressure may cause overheating and blower failure, it is therefore most important to have an accurate pressure gauge in the discharge line as close to the blower discharge as possible. Reduced speeds have a direct affect on allowable pressure (FIGURE 3-6 page 23 ). A bypass valve to bleed air from the discharge to atmosphere (FIGURE 2-2, page 11) may be used to control the pressure. NEVER reduce the blower speed to maintain a certain pressure before it is determined if the reduced speed is adequate for that pressure. An accurate pressure gauge must be maintained.

| | 11CDL23 | 11CDL27 | 11CDL31 |
|---|---|---|---|
| Liquid Rate (GPM) | 4 | 4 | 4 |

**FIGURE 3-3 – LIQUID RATE**

**Vacuum** – The blower may be operated either in dry vacuum or wet vacuum service. Do not operate the blower above the maximum vacuums shown in FIGURE 3-1, page 19, or below the minimum speed shown in FIGURE 3-6, page 19. All vacuum ratings are based on standard atmospheric discharge. An accurate vacuum gauge and vacuum relief valve must be used as close to the blower inlet as possible.

Wet vacuum service employs a suitable liquid, normally water, injected into the system near the blower inlet to control temperature rise and increase the degree of vacuum developed. The liquid used MUST BE clean and free of foreign matter, chemical contaminants and hardness, which may cause corrosion, deposits, or damage in the rotor chamber. See FIGURE 3-2, for typical installation, and FIGURE 3-4, page 21 for water quality requirements. If the proposed water supply is questionable, or does not meet the water specification, a reputable water treatment service company should be contacted. They can recommend treatment and equipment to satisfy this specification.

| | |
|---|---|
| pH Range at 25° C | 6.5 – 8.0 |
| Conductivity at 25°C (MICROMHO/cm) | Less than 250 |
| Total hardness as $CaCo_3$ (ppm) | Less than 100 |
| Total Alkalinity as $CaCo_3$ (ppm) | Less than 70 |
| Chloride ion; $Cl^-$ (ppm) | Less than 30 |
| Sulfate ion $SO_4^{-2}$ (ppm) | Less than 50 |
| Total iron; Fe (ppm) | Less than 0.3 |
| Silica; $SiO_2$ (ppm) | Less than 20 |
| Sulfide ion $S^{-2}$ (ppm) | 0 |
| Ammonium ion; $NH_4$+ (ppm) | 0 |

**FIGURE 3-4 – WATER QUALITY REQUIREMENTS**

If the injection water supply is allowed to run after blower shutdown, both the blower and adjacent discharge piping may fill with water and present a serious overload problem at the next attempted start. To prevent this, it is strongly recommended that an electric solenoid valve (normally open) be installed at the lowest point in the discharge elbow and/or connecting piping. The valve will open on blower shutdown and drain any water which might accumulate in the discharge piping. It is also recommended that a time delay be used between injection water shutoff and blower/motor shutdown to allow the interior of the blower to dry out prior to shutdown. Prior to shutdown, a dry out cycle of 5 minutes minimum with no water injection is required while the blower is running under no load.

On wet vacuum service, temperature control and a minimum amount of rotor sealing is obtained with small quantities (1 gallon per minute) of injected liquid. Best performance is attained by using the amount of injected liquid that maintains the discharge air temperature in the range of 100□to 150□F.

The maximum permissible liquid rate on any size machine is shown in (FIGURE 3-3, page, 20). DO NOT EXCEED THIS.

In applications where liquid carry--over from the upstream system may exceed these quantities, even for momentary periods, separation prior to blower inlet must be employed to reduce water flow to this figure or less.

Where inlet injection of water is used, it may be introduced in any convenient manner. No particular water pressure is required, only that sufficient to deliver the water to the injection point. A reliable metering device, such as a rotameter, to indicate water injection rate should be used.

Since water injection is used primarily for discharge temperature reduction and control, overheating will occur with water shutoff or supply failure. Provisions against inadvertent water shutoff should be incorporated in every water--injected blower system.

A high discharge temperature safety shutdown switch should be used to protect the blower.

Individual system requirements will determine whether downstream (discharge side) separation of injection water may be required. Combination discharge silencers and separators are available.

See Engineering Data Sheet 37--1--432, for complete wet vacuum details.

| Altitude (Feet above See Level) | Maximum Discharge Pressure* | Maximum Inlet Vacuum* |
|---|---|---|
| 1000 | 19.3 PSIG | 16.4 Inches Hg. |
| 2000 | 18.6 PSIG | 15.8 Inches Hg. |
| 3000 | 17.9 PSIG | 15.3 Inches Hg. |
| 4000 | 17.3 PSIG | 14.7 Inches Hg. |
| 5000 | 16.7 PSIG | 14.2 Inches Hg. |

* Gauge readings are taken as close as possible to blower openings. Above 5000 feet, consult the nearest Gardner Denver Office.

**FIGURE 3-5 – ALTITUDE – PRESSURE/VACUUM**

**ALTITUDE** – Maximum allowable discharge pressure and/or inlet vacuum will be decreased with operation at altitudes. See FIGURE 3-5.

**SPEED** – Refer to, page 19, for maximum and (Figure 3-6, page 23) for minimum speeds. Never operate the blower below the minimum or above the maximum speed shown. There is a definite relationship between blower speed, discharge pressure and/or inlet vacuum, and the resulting discharge air temperature. Reduced speed at high pressure or vacuum can cause excessive heating which may result in rapid blower failure. For engine-driven units provide an accurate speed indicator.

Examples of minimum allowable speed at given pressures or vacuums are listed in (FIGURE 3-6, page 23), as speed is reduced, pressure or vacuum must also be reduced.

EXAMPLE: Using a 11CDL27 blower, operating against 20 PSIG, minimum allowable speed is 1050 RPM.

## NOTICE

**Blower speed, line losses, elevation, and increased inlet temperatures will affect the maximum operating limitations.**

**OPERATING TEMPERATURE** – Blower air discharge temperature will increase with higher operating pressures or vacuums. Maximum allowable discharge is 355°F. If the discharge temperature continues to exceed 355°F., stop the blower at once and correct the trouble.

**⚠WARNING**

**Do not continue to run a blower that is overheating. Check the blower for damage before restarting.**

Lubricating oil temperature will increase with increasing discharge air temperature. Oil temperature in the discharge end sump will exceed that in the inlet end sump. Oil sump temperatures at the discharge end in the 200 – 275° F. range are not uncommon.

**STOPPING BLOWER** – Where possible, reduce the system pressure to zero gauge before stopping the blower. To prevent backflow of foreign material into the blower on shutdown, provide a check valve in the discharge line.

On engine-driven units, idle the engine for a few minutes prior to shutdown.

**EMERGENCIES** – In event of system failures, shutdown the blower immediately. Inspect the blower for foreign material backflow. If materials are found inside the blower housing, a thorough cleaning is necessary before restarting.

**⚠WARNING**

**Do not operate a blower which is noisy, vibrating, or heating excessively.**

| Models | Minimum Speed (RPM) – Dry Pressure | | |
|---|---|---|---|
| | Up to 15 PSIG | 18 PSIG | 20 PSIG |
| 11CDL23 | 800 | 800 | 900 |
| 11CDL27 | 800 | 860 | 1050 |
| 11CDL31 | 800 | 800 | 930 |

| Models | Minimum Speed (RPM) - Vacuum | | |
|---|---|---|---|
| | Dry Vacuum | Wet Vacuum | |
| | Up to 17” Hg. | Up to 22” Hg. | 24” Hg. |
| 11CDL23 | 840 | 800 | 800 |
| 11CDL27 | 900 | 800 | 800 |
| 11CDL31 | 800 | 800 | 800 |

**FIGURE 3-6 – MINIMUM SPEED, BASED ON PRESSURE OR VACUUM**

## BLOWER STARTUP CHECKLIST

This startup procedure should be followed during the initial installation and after any shutdown periods or after the blower has been worked on or moved to new location. It is suggested that the steps be followed in sequence and checked off (√) in the boxes provided.

- ☐ 1. Check the unit and all piping for foreign material and clean if required.
- ☐ 2. Check the flatness of the feet and the alignment of the drive. Feet that are bolted down in a bind can cause housing distortion and internal rubbing. Misaligned V-drives can cause the rotors to rub against the headplates and cause a reduction in the volumetric efficiency of the unit. Misaligned couplings can ruin bearings.
- ☐ 3. If the blower is V-belt driven, check the belt tension and alignment. Over-tensioned belts create heavy bearing/shaft loads which lead to premature failure.
- ☐ 4. Be sure adequate drive guards are in place to protect the operator from severe personal injury from incidental contact.
- ☐ 5. Check the unit for proper lubrication. Proper oil level cannot be over-emphasized. Too little oil will ruin bearings and gears. Too much oil will cause overheating and can ruin gears and cause other damage.
- ☐ 6. Turn the drive shaft by hand to be certain the rotors do not bind.
- ☐ 7. “Jog” the unit with the motor a few times to check that rotation is in the proper direction, and to be certain it turns freely and smoothly.
- ☐ 8. Start the unit and operate 15 minutes at no load. During this time, check for hot spots and other indications of interference.
- ☐ 9. Apply the load and observe the operation of the unit for one hour. Check frequently during the first day of operation.
- ☐ 10. If malfunctions occur, do not continue to operate. Problems such as knocking rotors can cause serious damage if the unit is operated without correction.

## SECTION 4
## MAINTENANCE

**GENERAL –** Blower efficiency and life depend on the quality of maintenance the blower receives. Maintenance must be done regularly and with care. Clean work space, tools, solvents and wiping rags are necessary to avoid transferring dirt into the unit. A maintenance chart listing each blower and scheduling regular maintenance of the unit is valuable. A good program, well carried out, will insure long trouble-free service from the blower.

**LUBRICATION –** Gears and bearings are splash lubricated. The discharge end sump requires 15-3/4 quarts and the gear end sump requires 8-1/2 quarts of oil. Filling with this amount of oil will bring the oil level to about the middle of the sight gauge. Add more oil if necessary to bring the level to the middle. DO NOT OPERATE THE BLOWER UNLESS OIL LEVEL IS AT THE MIDDLE OF THE SIGHT GAUGE. Do not overfill. Oil is added through the oil fill hole at the top of each bearing carrier. Check oil level only when machine is not operating and maintain at middle of each sight glass.

### RECOMMENDED LUBRICANT

AEON PD Synthetic Blower Lubricant is recommended. Refer to FIGURE 4-1, for AEON PD, AEON PD – FG (Food Grade) and AEON PD – XD (Extreme Duty) part numbers.

AEON PD is formulated especially for positive displacement blower service to provide maximum blower protection at most temperatures. Refer to (FIGURE 4-1). One filling of AEON PD will last a minimum of 4 times longer than a premium mineral oil, depending on actual operating conditions. Order AEON PD from your Gardner Denver distributor or call Gardner Denver directly.

| Convenient Package Sizes | AEON PD Part No. | AEON PD-FG Part No. | AEON PD-XD Part No. |
|---|---|---|---|
| 1 quart | 28G23 | 25H97 | 28G46 |
| Case 12 quarts | 28G24 | 28H98 | 28G47 |
| 1 gallon | 28G40 | 28H333 | 28G42 |
| Case 6 gallons | 28G41 | 28H334 | 28G43 |
| 5 gallon pail | 28G25 | 38H99 | 28G44 |
| 55 gallon drum | 28G28 | 28H100 | 28G45 |

**FIGURE 4-1 – AEON PD SYNTHETIC LUBRICANT**

| | | Ambient Temperatures | | | | |
|---|---|---|---|---|---|---|
| | | Less than 10° F | 10°F to 32° F | 32°F to 60° F | 60°F to 90° F | Greater than 90° F |
| Blower Discharge Temperature | Less than 32°F | AEON PD<br>AEON PD FG | AEON PD<br>AEON PD FG | | | |
| | 32°F to 100° F | AEON PD<br>AEON PD FG | AEON PD<br>AEON PD FG | AEON PD<br>AEON PD FG | AEON PD<br>AEON PD FG | |
| | 100°F to 225° F | AEON PD<br>AEON PD FG | AEON PD<br>AEON PD FG | AEON PD<br>AEON PD FG | AEON PD XD | AEON PD XD |
| | 225°F to 300° F | AEON PD<br>AEON PD FG | AEON PD<br>AEON PD FG | AEON PD<br>AEON PD FG | AEON PD XD | AEON PD XD |
| | Greater than 300° F | | AEON PD<br>AEON PD FG | AEON PD XD | AEON PD XD | AEON PD XD |

**FIGURE 4-2 – SYNTHETIC LUBRICANT CHART**

If not using AEON PD synthetic blower lubricant, use turbine quality oils with rust and oxidation inhibitors, anti-foam additives and viscosities listed in (FIGURE 4-3). Do not use oil that contains EP additives.

| Blower Discharge Temperature | Ambient Temperatures | | | |
|---|---|---|---|---|
| | **Less than 10° F** | **10°F to 32° F**** | **32°F to 90° F** | **Greater than 90° F** |
| Less than 32°F (0° C) | ISO 100 | ISO 100 | | |
| 32°F to 100° F (0° C to 38°C) | ISO 100 | ISO 100 | ISO 150 | |
| 100°F to 225° F (38° C to 105° C) | ISO 100 | ISO 100 | ISO 150 | ISO 220 |
| 225°F to 300° F (105° C to 149° C) | ISO 150 | ISO 150 | ISO 220 | ISO 220 |
| Greater than 300° F (149° C) | | | *** | *** |

**FIGURE 4-3 – NON-SYNTHETIC LUBRICANT CHART**

* For ambient temperatures less than 10° F, but not less than -20° F, the use of sump heaters, heated enclosures or synthetic lubricant is required.

** For ambient temperatures 10° F to 32° F, the use of oil sump heaters, heated enclosures or synthetic lubricant is recommended.

*** The lubricant viscosity must be 70 SUS minimum at the lubricant operating temperature.

The pour point of the lubricant should be at least 5° to 10° F below the minimum expected ambient temperature.

For continuous operation, where the lubricant temperature exceeds 200° F, synthetic lubricant is recommended.

Check the oil level at both ends of the blower daily. The oil change period is governed by operating conditions, such as load, temperature, dirt, humidity, fumes and the quality of oil used. Under severe operating conditions the oil should be changed every 1000 hours or more often. Under ideal operating conditions oil may extend the change interval up to 6000 hours based on a good oil analysis program. Good practice is to change the oil often enough that it appears clean and clear when drained from the sump. Oil sump should be flushed with a clean solvent every forth oil change. Always use clean containers for oil and cleaning solvents.

## MAINTENANCE

### AIR FILTERS AND FILTER-SILENCERS

**⚠WARNING**

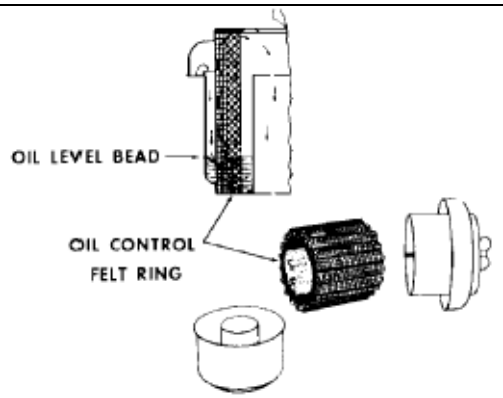
**Servicing the air filters is one of the most important maintenance operations to be performed to ensure long blower life.**

Servicing frequency of filter elements is not time predictable. A differential pressure indicator, with a continuous gauge reading, should be installed across the inlet filter. It will tell how much of the service life of the filter element has been used. It will also eliminate both premature filter servicing and premature blower failure due to a plugged filter when the filter pressure drop is used to establish maintenance points.

In all cases refer to the filter manufacturer's service instructions. Due to the many types of filters, it is not practical to give specific instructions covering all models; however, the following paragraphs describe some of those most commonly used.

**NOTICE**

**No matter what type of filter is used, always make sure all seals, gaskets, clamps and hose connections on the filter and inlet line are absolutely air tight. Each time the filter is serviced, inspect interior of the blower for dirt.**




| TEMPERATURE | OIL USED |
|---|---|
| -20° F to 0° f | Mixture of 2/3 SAE 10W and1/3 Diesel Fuel |
| 0° to 30° F | SAE 10W |
| 30° to 50° F | SAE 20 |
| 50° to 110° F | SAE 30 |
| 110° to 112° F | SAE 50 |

**FIGURE 4-4 – OIL BATH FILTER**

**Oil Bath Filter** (FIGURE 4-4, page 27) – The following instructions also apply when the filter is equipped with a silencing chamber:

1. Remove cover, screen and bowl form the base.
2. Wash the screen and bowl.
3. Fill the bowl to oil level bead with oil listed.
4. Place the end of the screen bonded with felt down into the oil. Upside-down installation will result in heavy oil carryover.
5. Replace the cover and tighten wing nut securely.
6. Make sure all connections to the air filter are tight.

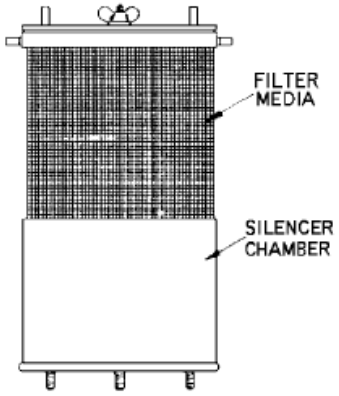



**FIGURE 4-5 – OIL WETTED FILTER-SILENCER**

**Oil Wetted Filter-Silencer** (FIGURE 4-5, page 28) – Cleaning of the filtering media is accomplished by thoroughly washing in a commercial solvent and blowing dry with air. Blow from inside to outside to dislodge dirt particles from the finer screen sections. After the silencer can be supplied with an all-weather hood. If an oil wetted filter without silencer is used, the service instructions in the previous section will also apply.

**Dry Type Filter and Filter-Silencer** (FIGURE 4-6, page 28) – When the outside surface of the element appears to be evenly coated with dirt, it should be cleaned as follows:

1. Remove wing nuts and lift off the hood.
2. Loosen the outside retaining strap to remove the media.
3. Vibrate or blow off heavy dirt accumulation.
4. If required, wash the media in any carbon base commercial solvent and blow off the excess solvent.
5. Allow to dry and examine for damage or conditions requiring replacement.

Because the media in the dry type filter is of wool felt, it may become impregnated with oil or water, if present in any large degree. Corrosive gases may also attack the media. While such conditions are not common, they should be kept in mind.

**FIGURE 4-6 – DRY TYPE FILTER AND FILTER-SILENCER**

**DISCHARGE SILENCER** – A drain may be provided in the silencer at the lowest point for draining condensate. Draining intervals will depend upon humidity conditions and must be established by the user.

**ROTOR SHAFT SEALS** – Rotors have a labyrinth type shaft air seal to minimize air leakage along the shaft from the compression chamber. More air will leak through the seals at the discharge end since they are under higher air pressure. Excessive air leakage indicates shaft seal failure.

The air seal consists of two parts, a hardened steel bearing spacer with grooves cut into the outside diameter, and a steel-backed babbitt ring (shaft seal) pressed into the bearing carrier. The grooved end of the spacer and the shaft seal bore have a close fit when cold. When the blower reaches operating temperature for the first time, the babbitt embeds slightly into the grooves, forming a close running fit to control air leakage along shaft. No maintenance is required, except that bearing carrier removal usually will destroy the babbitt grooving and the shaft seal must be replaced. Shaft seals that have been in operation should not be reused as excessive leakage may result. The bearing spacer can be reused unless damaged. After installation of new seals, rotation of the blower may be tight for a few turns until bearing spacer grooves cut running ways into the babbitt. For seal replacement refer to Disassembly Section, page 36, and Assembly Section, page 40.

**BEARING OIL SEALS** – Oil leakage along each shaft from the oil sumps is prevented by a hydrodynamic lip type seal pressed into the bearing carrier. These seals are unidirectional lip seals. The hydrodynamic spiral in the Teflon lip pumps the oil back into the sump. Usual causes of seal failure are: high temperature, rough surface on bearing spacer, damage during installation, and improper seal used. The radius at the end of the bearing spacer and O.D. should be highly polished to prevent seal lip damage during installation. Use only seals shown in parts list as they have been selected for blower service. They must be installed in the correct location and with the proper orientation or the oil will be pumped out of the blower. Rotation arrows and color coding are used to distinguish clockwise seals from counterclockwise seals,
see Figure 7-13, page 45.

**PERIODIC INSPECTIONS** – A well-organized maintenance program will provide for periodic inspection of the blower, drive and components. These inspections may prevent major repair and downtime.

1. Observe the blower for vibration, heating, noise, oil seal leaks, and excessive shaft air leaks.
2. Check for proper operation of the filters, coupling, drive, power unit, relief and check valves, gauges and other controls.
3. Disconnect the drive and turn the blower by hand to check for drag, tight spots, bearing wear (radial and axial) and gear backlash. Rotation should be free with no indication of drag or metallic interference.
4. Inspect the interior through the inlet or discharge port for cleanliness, corrosion or parts contact.

**⚠WARNING**

**Rotating components will cause severe injury in case of personal contact. Keep hands away from the blower inlet and discharge ports.**

5. Check tightness of all screws and bolts.

**SOME COMMON CAUSES OF BLOWER FAILURE**

1. Poor air filter maintenance or incorrect selection.
2. Inadequate lubrication (wrong, dirty or low oil).
3. Backflow of materials into the blower.
4. Discharge pressure or inlet vacuum above blower rating.
5. Blower speed below minimum rating.
6. Blower speed too low for discharge pressure or inlet vacuum.

**BLOWER OVERHAUL** – Refer to Disassembly Section, page 36, and Assembly Section, page 40.

**REPAIR PARTS** – When ordering parts, specify Blower Model, Size and Serial Number.

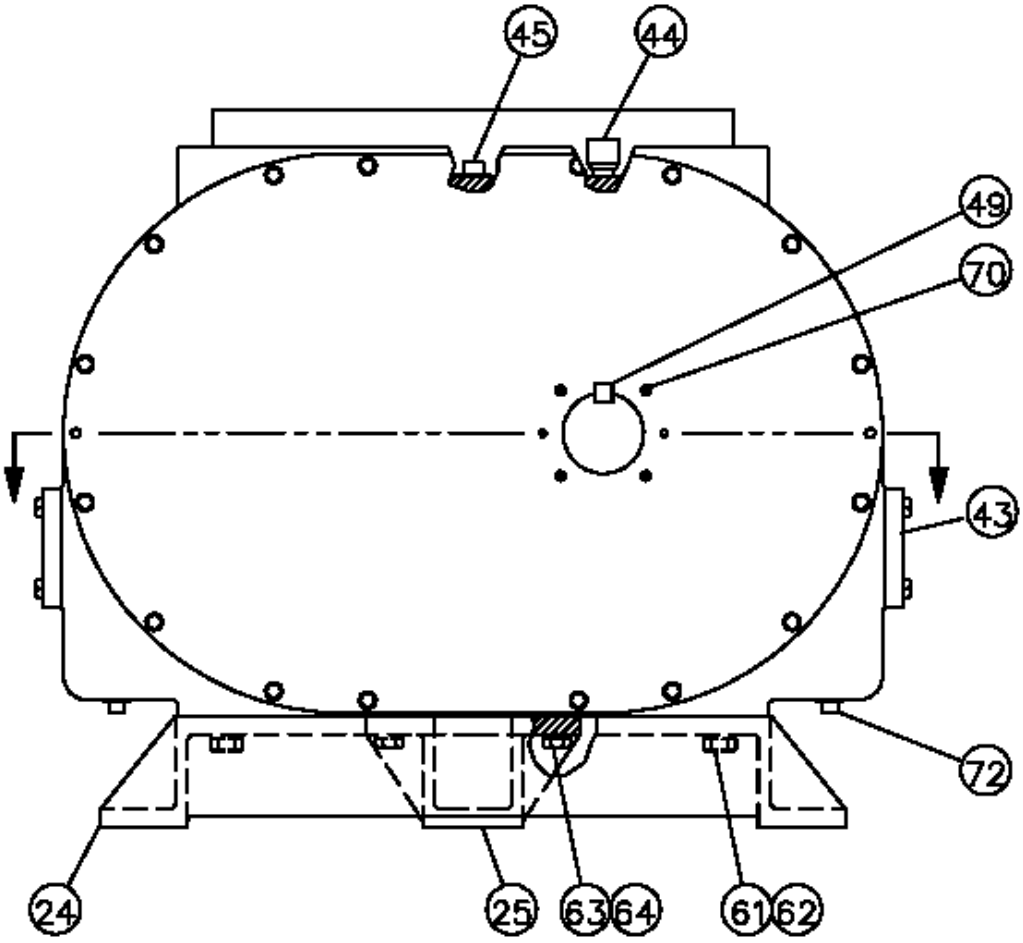
Reference numbers shown in the left hand column of the parts list are used to help locate parts shown on the drawing and sectional view. DO NOT ORDER BY REFERENCE NUMBERS.

After locating the reference number, the part number may be found for your particular blower under the correct Model Number Column.

Specify exactly the number of parts required (see column “Qty.”). DO NOT ORDER BY SETS.

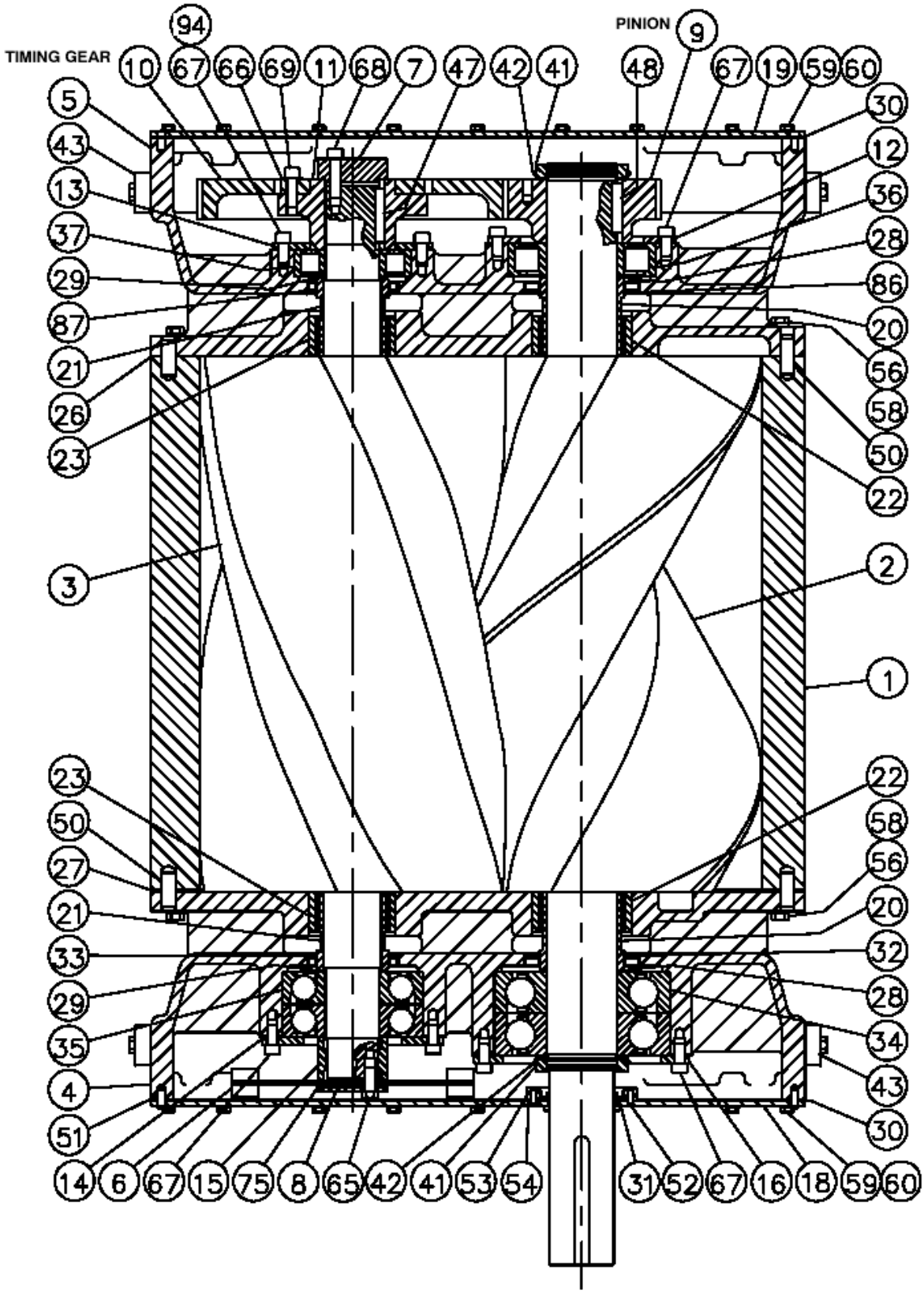
Teflon is a register trademark of DuPont

**SECTIONAL VIEW**
**11CDL_ _ P – TOP INLET**




**300CBT799-B**
**(Ref. Drawing)**

FOR LIST OF PARTS SEE PAGES 33 AND 34.




FOR LIST OF PARTS SEE PAGES 33 AND 34

**300CBT799-B**
**(Ref. Drawing)**

**Order by Part Number and Description. Reference Numbers are for your convenience only.**

| Ref. No | Name of Part | Qty. | Models 11CDL23P Part No. | Models 11CDL27P Part No. | Models 11CDL31P Part No. |
|---|---|---|---|---|---|
| 1 | HOUSING | 1 | 301CBT002 | 302CBT002 | 303CBT002 |
| | GROUP--ROTOR (Includes Ref. Nos. 2 & 3) | 1 | 200CBT010A | 203CBT010C | 205CBT010A |
| 2 | ** ROTOR | 1 | | | |
| 3 | ROTOR--GATE ASSEMBLY | 1 | | | |
| 4 | CARRIER--BEARING (DISCHARGE END) | 1 | 211CBT006 | 213CBT006 | 215CBT006 |
| 5 | CARRIER--BEARING (GEAR END) | 1 | 210CBT006 | 212CBT006 | 214CBT006 |
| 6 | SLINGER—OIL | 1 | 8508482 | 8508482 | 8508482 |
| 7 | PLATE--SHAFT CLAMP | 1 | 8500739 | 8500739 | 8500739 |
| 8 | PLATE--SHAFT CLAMP | 1 | 8508476 | 8508476 | 8508476 |
| | GEAR KIT (Includes Ref. Nos. 9 & 10) | 1 | 300CBT6008 | 300CBT6008 | 300CBT6008 |
| 9 | GEAR—TIMING | | | | |
| 10 | GEAR—PINION | | | | |
| 11 | HUB—GEAR | 1 | 8500742 | 8500742 | 8500742 |
| 12 | PLATE--BEARING CLAMP | 1 | 8508479 | 8508479 | 8508479 |
| 13 | PLATE--BEARING CLAMP | 1 | 8508478 | 8508478 | 8508478 |
| 14 | PLATE--BEARING CLAMP | 1 | 8508477 | 8508477 | 8508477 |
| 15 | SPACER | 1 | 8508480 | 8508480 | 8508480 |
| 16 | RETAINER | 1 | 200CBT205 | 200CBT205 | 200CBT205 |
| 18* | COVER—END | 1 | 8500746 | 8500746 | 8500746 |
| 19 | COVER—END | 1 | 8500747 | 8500747 | 8500747 |
| 20 | SPACER—BEARING | 2 | 8500749 | 8500749 | 8500749 |
| 21 | SPACER—BEARING | 2 | 8504514 | 8504514 | 8504514 |
| 22 | SEAL--ROTOR SHAFT | 2 | 8500750 | 8500750 | 8500750 |
| 23 | SEAL--ROTOR—SHAFT | 2 | 8500390 | 8500390 | 8500390 |
| 24 | FOOT—SUPPORT | 1 | 8500752 | 8500752 | 8500752 |
| 25 | FOOT—SUPPORT | 1 | 8500751 | 8500751 | 8500751 |
| 26 | SHIM—HOUSING | 1 | 8500753 | 8500753 | 8500753 |
| 27 | SHIM--HOUSING SET | 1 | 8500760 | 8500760 | 8500760 |
| 28 | SHIM--SHAFT SET | 2 | 8500269 | 8500269 | 8500269 |
| 29 | SHIM--SHAFT SET | 2 | 8501514 | 8501514 | 8501514 |
| 30 | GASKET | 2 | 8500761 | 8500761 | 8500761 |
| 31* | SEAL—OIL | 1 | 8500068 | 8500068 | 8500068 |
| 32 | SEAL—OIL | 1 | 305CBT199 | 305CBT199 | 305CBT199 |
| 33 | SEAL—OIL | 1 | 300CBT199 | 300CBT199 | 300CBT199 |
| 34 | BEARING--ANGULAR CONTACT | 2 | 8500411 | 8500411 | 8500411 |
| 35 | BEARING--ANGULAR CONTACT | 2 | 8508458 | 8508458 | 8508458 |
| 36 | BEARING—ROLLER | 1 | 8500045 | 8500045 | 8500045 |
| 37 | BEARING—ROLLER | 1 | 8500044 | 8500044 | 8500044 |
| 41 | LOCKNUT—BEARING | 2 | 50Z18 | 50Z18 | 50Z18 |
| 42 | WASHER | 2 | 95N18 | 95N18 | 95N18 |
| 43 | SIGHT GLASS OIL LEVEL | 4 | 300GFJ436 | 300GFJ436 | 300GFJ436 |
| 44 | BREATHER—CRANKCASE | 2 | 5L223 | 5L223 | 5L223 |

Order by Part Number and Description. Reference Numbers are for your convenience only.

| Ref. No | Name of Part | Qty. | Models 11CDL23P Part No. | Models 11CDL27P Part No. | Models 11CDL31P Part No. |
|---|---|---|---|---|---|
| 45 | PLUG--SQHD PIPE | 2 | 64AA1 | 64AA1 | 64AA1 |
| 47 | KEY—SQUARE | 1 | 8500117 | 8500117 | 8500117 |
| 48 | KEY—SQUARE | 1 | 8500082 | 8500082 | 8500082 |
| 49 | KEY—SQUARE | 1 | 8508545 | 8508545 | 8508545 |
| 50 | PIN—DOWEL | 4 | 62M112 | 62M112 | 62M112 |
| 51 | PIN—DOWEL | 2 | 62M50 | 62M50 | 62M50 |
| 52 * | PIN—DOWEL | 2 | 62M22 | 62M22 | 62M22 |
| 53 * | ADAPTOR—SEAL | 1 | 8500762 | 8500762 | 8500762 |
| 54 * | GASKET--SEAL ADAPTOR | 1 | 8500763 | 8500763 | 8500763 |
| 56 | SCREW | 36 | 655EE090 | 655EE090 | 655EE090 |
| 58 | LOCKWASHER | 36 | 95B5 | 95B5 | 95B5 |
| 59 | SCREW--HEX HD | 36 | 655ED04N | 655ED04N | 655ED04N |
| 60 | LOCKWASHER | 36 | 95B3 | 95B3 | 95B3 |
| 61 | SCREW | 4 | 655EF070 | 655EF070 | 655EF070 |
| 62 | LOCKWASHER | 4 | 95B8 | 95B8 | 95B8 |
| 63 | SCREW | 2 | 655EF070 | 655EF070 | 655EF070 |
| 64 | LOCKWASHER | 2 | 95B7 | 95B7 | 95B7 |
| 65 | SCREW | 3 | 655EE05N | 655EE05N | 655EE05N |
| 66 | WASHER | 5 | 95W49 | 95W49 | 95W49 |
| 67 | SCREW SOHD CAP | 16 | 75P75N | 75P75N | 75P75N |
| 68 | SCREW SOHD CAP | 3 | 75P77N | 75P77N | 75P77N |
| 69 | SCREW SOHD CAP | 5 | 75P2N | 75P2N | 75P2N |
| 70 * | SCREW SOHD CAP | 4 | 75P4N | 75P4N | 75P4N |
| 72 | PLUG—MAGNETIC | 4 | 64BJ4 | 64BJ4 | 64BJ4 |
| 75 | SHIM | 1 | 77H68 | 77H68 | 77H68 |
| 86 | SEAL – OIL | 1 | 304CBT199 | 304CBT199 | 304CBT199 |
| 87 | SEAL – OIL | 1 | 301CBT199 | 301CBT199 | 301CBT199 |
| 89** | SLEEVE – WEAR | 1 | 80M18 | 80M18 | 80M18 |
| 94 | SHIM SET – BEARING RETAINER | 1 | 303CBT732 | 303CBT732 | 303CBT732 |

* Double the quantity required for double extended driveshaft construction

Refer to Drawings on page 32 and 33.

** Rotors must be ordered and used in matched pairs.

NOTE: All units as listed are for the standard top inlet construction. For units built with optional top discharge construction, all parts are the same except Bearing Carriers. Order as follows:

| | | 11CDL23 | 11CDL27 | 11CDL31 |
|---|---|---|---|---|
| Ref. No. 4 | Discharge End | 217CBT006 | 219CBT006 | 221CBT006 |
| Ref. No. 5 | Inlet End | 216CBT006 | 218CBT006 | 220CBT006 |

## OVERHAUL KIT – 312CBT6010

| | Description | Qty. | Part No. |
|---|---|---|---|
| | Installation Sleeve for Oil Seal | 1 | 300CBT074 |
| | Installation Sleeve for Oil Seal | 1 | 300CBT074 |
| | Installation Sleeve for Oil Seal | 1 | 301CBT074 |
| | Bearing Spacer | 2 | 8500749 |
| | Bearing Spacer | 2 | 8504514 |
| | Shaft Rotor Seal | 2 | 8500750 |
| | Shaft Rotor Seal | 2 | 850039 |
| | Shim Housing | 1 | 8500753 |
| | Shim Housing Set | 1 | 8500760 |
| | Shaft Shim Set | 2 | 8500269 |
| | Shim | 2 | 8501514 |
| | Cover Gasket | 2 | 8500761 |
| * | Oil Seal | 1 | 8500068 |
| * | Oil Seal | 1 | 305CBT199 |
| | Oil Seal | 1 | 302CBT199 |
| | Ball Bearing (Angular Contact) | 2 | 8500411 |
| | Ball Bearing | 2 | 8508458 |
| | Roller Bearing | 1 | 8500045 |
| | Roller Bearing | 1 | 8500044 |
| | Bearing Locknut | 2 | 50Z18 |
| | Bearing Lockwasher | 2 | 95N18 |
| | Gasket-Seal Adaptor | 1 | 8500763 |
| | Screw | 3 | 655EE05N |
| | Washer | 5 | 95W49 |
| | Screw SOHD Cap | 16 | 75P75N |
| | Screw | 3 | 75P77N |
| | Screw SOHD Cap | 5 | 75P2N |
| | Screw SOHD Cap | 4 | 75P4N |
| | Oil Seal | 1 | 304CBT199 |
| | Oil Seal | 1 | 301CBT199 |
| | Sleeve – Wear | 1 | 80M18 |
| | Shim Set – Bearing Retainer | 1 | 303CBT732 |

**IMPORTANT:** For spare parts requirement in remote areas, export or where more than one unit is operating, a spare gear set is recommended.
For 11CDL series order Gear Kit Part Number 300CBT6008.

**NOTE:** Overhaul kit is recommended for spare parts and/or scheduled maintenance or overhaul requirements. The installation sleeves are reusable. The overhaul kit without the seal installation sleeves is part number 301CBT6010.

* Seals must stay on the shipping rings until it is time to install them. Otherwise the lips will deform.

## SECTION 6
## DISASSEMBLY INSTRUCTIONS

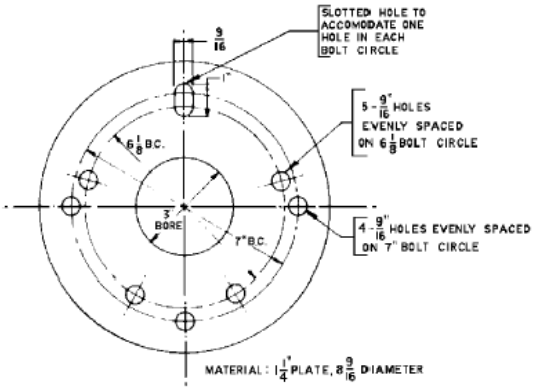



**FIGURE 6-1 – ADAPTOR PLATE**

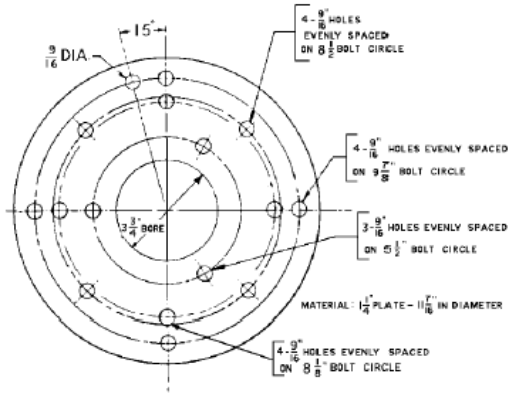



**FIGURE 6-2 – BEARING PRESS PLATE**

| NOTICE |
|---|
| **Illustrations for Disassembly Instructions are taken from various sizes of CycloBlower. Minor variations in construction of some parts need cause no concern.** |

1. Provide adaptor plates, (Figure 6-1), and bearing press plate, (Figure 6-2), for pulling the gear hub and pinion, and for installing bearings.

2. Provide bearing press plate, (FIGURE 6-2), for pulling the pinion gear and for installing the main rotor bearings. **Pulling directly on pinion teeth will cause gear wear. Pulling directly on the gear hub flange will distort the flange causing gear run-out**. The adaptor plates shown are designed for a jaw type hydraulic puller, (Figure 6-4, and Figure 6-5, page 36 & 37). Other type pullers are available, and if used, suitable adaptor plates should be provided.

**FIGURE 6-3 – SPANNER WRENCH**

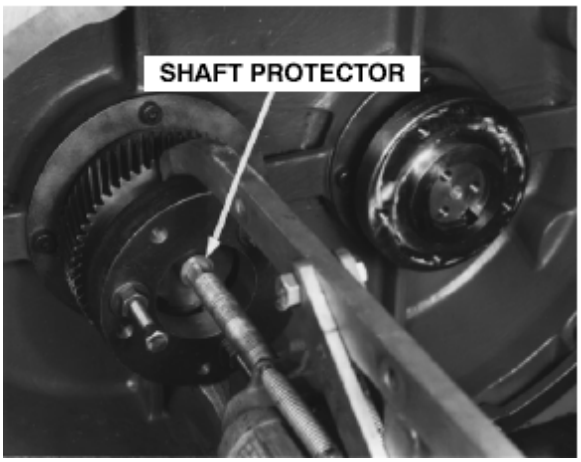



**FIGURE 6-4 – BEARING PRESS PLATE**

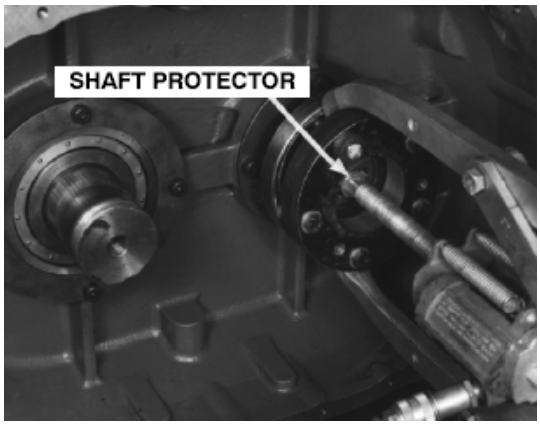


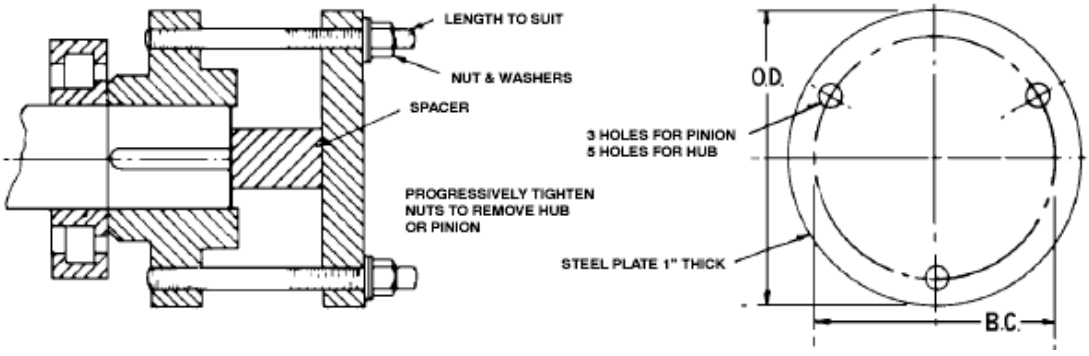

**FIGURE 6-5 – ADAPTOR PLATE**

3. Place the unit in a horizontal position, on a solid blocking, so the gear end bearing carrier hangs free. Drain oil from both carriers. At the gear end remove the cover, hub retainer plate, gear (slip fit on hub) and pinion locknut. A spanner wrench similar to that shown in (FIGURE 6-3, page 36), should be made to prevent damaging the locknut. This wrench is especially useful at assembly in saving time, and more important, assures proper tightening of the nuts.
4. Mount the bearing press plate and puller (FIGURE 6-4, page 36), and pull the pinion. Be sure to use a shaft protector to prevent damage to the end of the shaft. Remove the key from the shaft.
5. Mount the adaptor plate and puller (FIGURE 6-5), and pull the gear hub. Use a shaft protector. Remove the key from the shaft.
6. If a hydraulic puller is not available, the hub and pinion may be pulled as shown in (FIGURE 6-6).

**⚠ WARNING**

**Do not use a torch to heat the pinion to aid in removal. The pinion can be damaged by concentrated heat.**

7. Remove all gear end bearing carrier to housing screws. With four jack screws in tapped holes in the carrier flange, (FIGURE 6-7, page 38), pull the carrier. This also pulls bearings from the rotor shaft. Tighten jack screws evenly to prevent binding carrier on dowel pins and bearings. Support the carrier so it does not drop and damage shaft extensions. When the carrier is free, remove the bearing retainers, bearings, lip type oil seal and shaft seal. If the bearings are to be used, handle with care.




| PINION | | | | | GEAR HUB | | | |
|---|---|---|---|---|---|---|---|---|
| O.D. | B.C. | Holes | Stud | | O.D. | B.C. | Holes | Stud |
| 7-3/4” | 6-1/8” | (3) 9/16” | 1/2” – 13” UNC | | 7-1/4” | 5-1/2” | (5) 9/16” | 1/2” – 13” UNC |

**FIGURE 6-6 – ALTERNATE ADAPTOR PLATES**

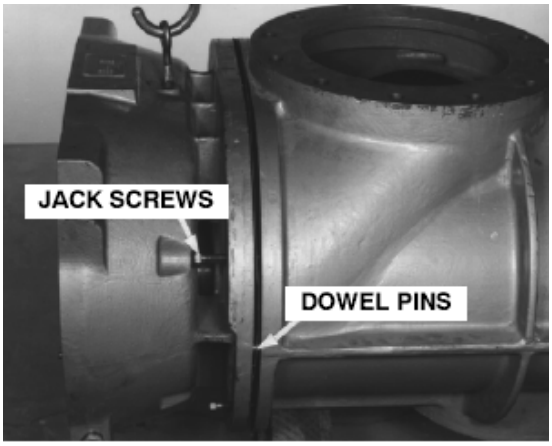



**FIGURE 6-7 – BEARING CARRIER**

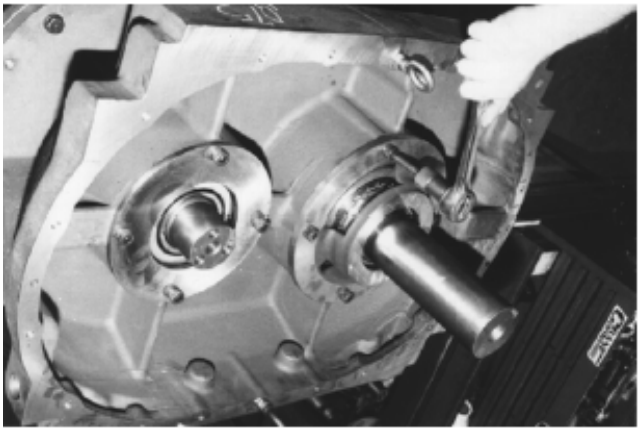


**FIGURE 6-8 – BEARING CLAMP PLATE**

| NOTICE |
| --- |
| **Never reuse shaft seals that have been in operation. Refer to "Rotor Shaft Seals," page 29.** |

8. Remove the discharge end carrier cover, oil slinger, clamp plate, bearing locknut and bearing clamp plates. See (FIGURE 6-8).

9. Rig the plate (shown in FIGURE 6-2, page 36) and the puller shown in (FIGURE 6-9) and press the rotor shaft through the bearings. Use a shaft protector. Be sure the bolts holding the plate are threaded into the tapped holes of the bearing housing far enough to prevent stripping of the threads, and evenly adjust so the plate is square with the shaft. Press one rotor through the bearing at a time, then proceed to Step 10. Repeat Steps 9 and 10 on the second rotor.

10. When the rotor shaft is free of bearings, work the rotor through the housing and rig a sling to complete removal of the rotor from the housing, (FIGURE 6-10. page 39). Handle with care to prevent burrs on rotors and housing.

11. After removal of the rotors, rearrange blocking so the discharge end bearing carrier hangs free. Remove all screws and jack the carrier evenly from the dowel pins, FIGURE 6-11, page 39). Support the carrier as it is removed.

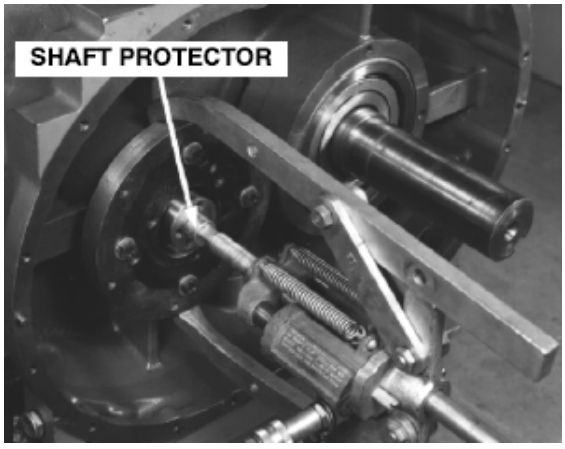



**FIGURE 6-9 – PULLER**

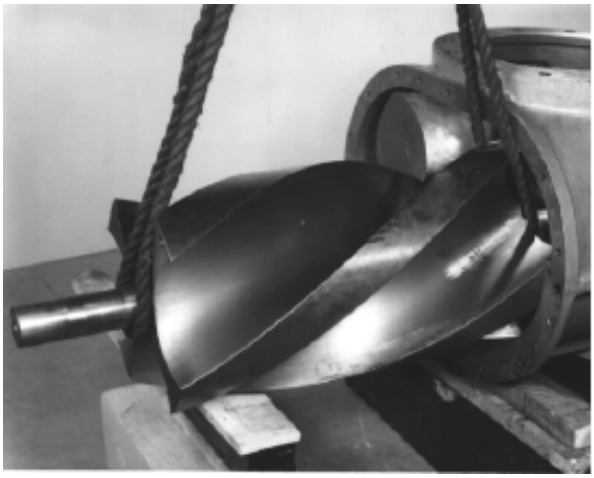


FIGURE 6-10 – ROTOR REMOVAL

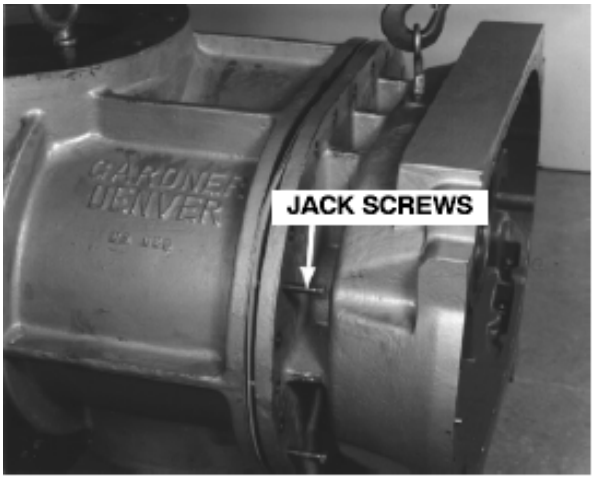



FIGURE 6-11 – BEARING CARRIER

## SECTION 7
## ASSEMBLY INSTRUCTIONS

**NOTICE**

**The fastener & locknut torque values required during assembly are shown in FIGURE 7-33.**

**NOTICE**

**Illustrations for Assembly Instructions are taken from various sizes of Cycloblower minor variations in construction of some parts should not cause concern.**

**⚠WARNING**

**Numbers in parentheses ( ) refer to key numbers in assembly drawings on pages 31 and 32.**

The CycloBlower® is manufactured with close tolerances for efficient operation. All parts must be handled carefully to prevent burrs which will give false clearance readings and/or cause rapid wear.

All parts and oil passages must be thoroughly cleaned of dirt which will cause galling of close running parts. Clean work area, washing tank, tools and wiping rags must be provided.

Refer to Parts List, Section 5, page 31 and 32, for sectional views showing complete assembly of parts.

**NOTICE**

**The following illustrations are of a standard blower with top inlet, bottom discharge, main rotor discharge end drive, main rotor discharge end drive. Some variations will be noticed in the following illustrations for blowers of other arrangements.**

There may be cases where foreign materials have entered the blower, or other causes have resulted in galling of the rotor ends, carrier faces, rotor lobes, or housing walls. Since the blower is designed with no contact of parts within the rotor chambers, these parts may be cleaned and polished for reuse unless galling is severe. Reuse of parts severely galled may result in loss of blower efficiency. All damaged parts which have been reworked should be checked for run-out or warpage before reuse.

Assembly of the “P” Series CycloBlower differs from earlier models in the approach to installing the oil seals. On previous models the installation of the lip seals into the bearing carriers was the first step in the assembly process. This was acceptable for seals with compliant lips but the hydrodynamic lip seals are made of Teflon and could be damaged by mishandling. On the “P” Series, the lip seals are not installed into the bearing carriers until after the rotors have been assembled. This requires that the lip seal is slipped over the rotor shaft so a hollow cylindrical pusher is needed as well as a short installation sleeve.

1. Oil the O.D. of the rotor shaft seals (22, 23) to prevent seizure and press into each bore of the gear end bearing carrier (5) (FIGURE 7-1, page 41). NEVER REUSE SHAFT SEALS. Refer to “Rotor Shaft Seals,” page 28, for an explanation. A simple press utilizing a bolt and two bars, one across the seal and one underneath across the bearing bore, is an effective method for installing the seal. Tightening the nut on bolt presses the seal into place. Press the seal .010” to .015” below the face of the carrier to prevent the end of the rotor from rubbing the end of the seal. A simple method is to place a .010” to .015” shim on the end of the seal under the press bar which will allow the seal to be pressed the correct distance below the face of the carrier. Handle the seal with care to prevent damage to babbitt lining.

2. To ease assembly in later steps, fit the bearing spacers (20, 21) to the seals (22, 23) (FIGURE 7-2, page 41). Be sure there are no burrs on the spacer O.D. and seal I.D. Spacer should be SLIP FIT in the seal. A sloppy fit will cause excess air leakage and decrease blower efficiency. Do not drive the spacer through the seal as damage to the babbitt will result. It may be necessary to polish the high spots from the seal I.D. to allow slip fit of the spacer. USE CROCUS CLOTH, not emery cloth.

   Never push the grooved end of the spacer through the bearing oil seal as the lip of the seal may be damaged. Apply Loctite 620 to the ID of the bearing spacer. When the spacers are fitted, slide them on the gear end shaft extension of the rotors with the grooved end toward the rotor. Make sure there are no burrs on either end of the spacer or end of the rotor. Place tape around the shaft to prevent the spacer from sliding off as shown in (Figure 7-4, page 41).

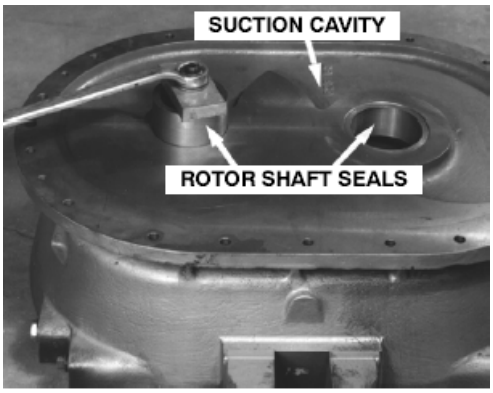



**FIGURE 7-1 – ROTOR SHAFT SEAL**

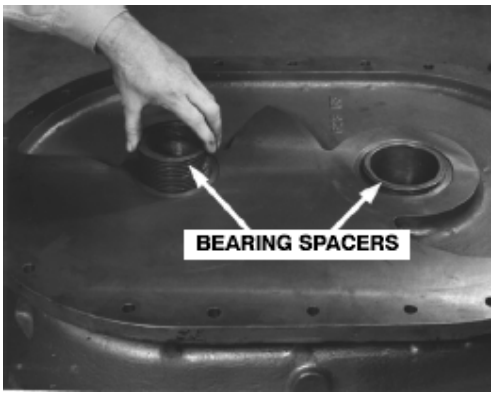



**FIGURE 7-2 – BEARING SPACER**

3. Place .030" thick aluminum shim (26) on the gear end bearing carrier (5). The pointed section of the shim is positioned on the machined surface of the carrier to match the contour of the housing. Lower the housing (1), as level as possible, onto the carrier with the discharge opening up (Figure 7-3), and the inlet opening matching the cavity side (FIGURE 7-1, page 41), of the carrier. Engage the dowel pins (50) with matching holes in the carrier with care. Tighten the carrier to housing screws (56, 58) evenly so the dowel pins will not be damaged.
4. Be sure the ends of the rotors (2, 3) and machined face of the carrier are free of burrs and dirt. Lower the gate rotor (3) into the housing (1) first (Figure 7-4). The gear end shaft extension, with the bearing must be suspended plum when lowering so the shaft extension and bearing spacer can be carefully guided through the close fit of the shaft seal without damage to the babbit of the air seal. On older models, match timing marks on the end of the rotor lobes as shown in (FIGURE 7- 9, page 43). Rotors must be used in matched pairs. Identifying marks are stamped on the O.D. of the rotors on the same lobe as the timing marks.

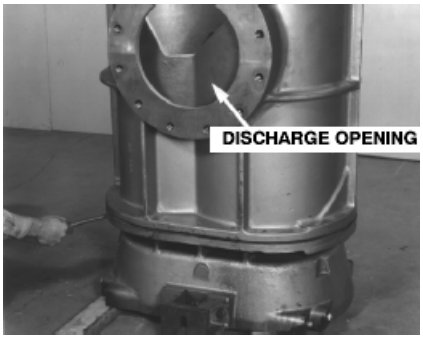



**FIGURE 7-3 – DISCHARGE OPENING**

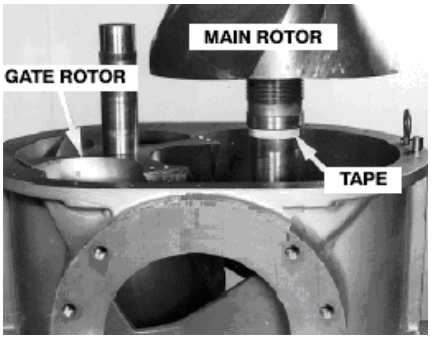



**FIGURE 7-4 – ROTORS**

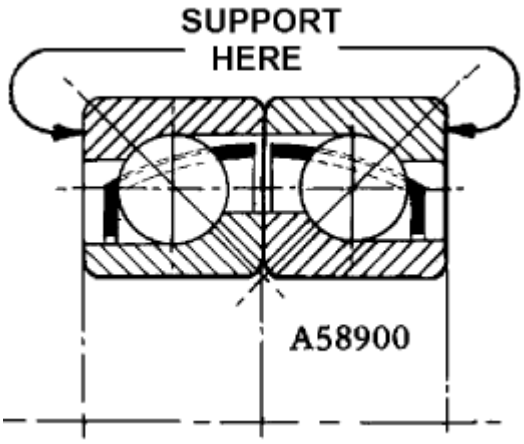



**FIGURE 7- 5 – ANGULAR CONTACT BEARING ASSEMBLY**

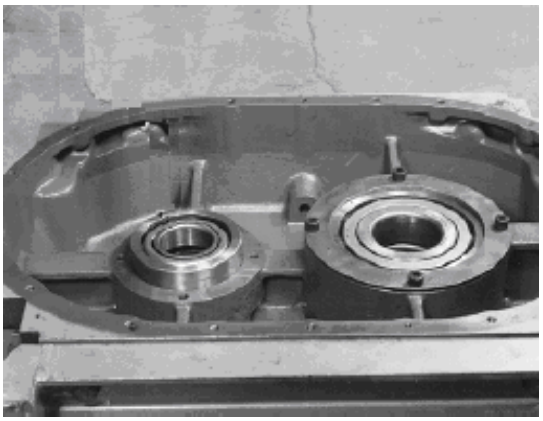


**FIGURE 7-6 – BEARING INSTALLATION**

| NOTICE |
| --- |
| **If rotors are installed in reverse of above instructions, the gate rotor bearing spacer O.D. may drag on the main rotor lobe and be damaged.** |

**The CycloBlower is designed for no metal-to-metal contact** with parts within the housing. To achieve this, some preliminary measurements are necessary before completing the assembly. **The first set of measurements are used to determine the shaft shim set thickness necessary for positioning the rotors in the housing to give the required clearance between the end of the rotors and the carrier face at the discharge end.** End clearance is maintained at the discharge end by two angular contact bearings (34, 35), bearing spacer (20, 21) and shim set (28, 29). The shaft shim set is determined as outlined in Steps 5 thru 8.

5. The angular contact bearings (34, 35) must be assembled as shown in (FIGURE 7- 5) to assure a “fixed” bearing. The marked face of the inner bearing is placed down in the bearing bore; the marked face of the outer bearing is placed up.
6. Install the shaft seal (22, 23), and fit the bearing spacers (20, 21) in the discharge end bearing carrier (4) using the same method as outlined in Steps 1 and 2, page 40 and 41. To prepare for shim set measurement, slip bearings (34, 35) into the bore and install bearing retainer plate (14, 16), FIGURE 7-6. **Bearings must be assembled as directed in Step 5**. Bearings are slip fit in the bore.
7. Inspect bearing spacers for burrs on either end and polished area of O.D. Slip bearing spacer through the shaft seal with the polished end toward the bearing. Make sure the spacer is resting solidly against the bearing. With depth micrometer, measure the distance from the face of the carrier to the end of each of the bearing spacers, FIGURE 7-7, page 42.

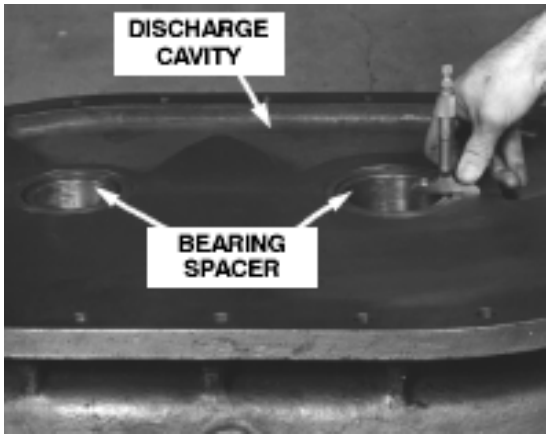



**FIGURE 7-7 – DISCHARGE END BEARING CARRIER**

| Models | Total End Clearance (Suction & Discharge | Suction End | Discharge End |
|---|---|---|---|
| 11CDL23 | .041 | .029 | .012 |
| 11CDL27 | .046 | .034 | .012 |
| 11CDL31 | .051 | .039 | .012 |

Dimensions are for Ideal Clearances. Allow +/- for Tolerance

**FIGURE 7-8 – ROTOR END CLEARNACE CHART (UNIT COLD)**

8. To the micrometer reading add discharge end clearance shown in clearance chart, FIGURE 7-8, page 43, and .002" for crush fit of shims and parts. This sum gives the thickness of the shim set (28, 29) for positioning the rotor the required distance from the face of the carrier for running clearance at the discharge end.

   EXAMPLE FOR 11CDL31 BLOWER: Micrometer reading of .060" plus .012" discharge end clearance, FIGURE 7-8, page 43, plus .002" crush gives shim set thickness of .074".
   Figure shim set for each rotor and record measurements which will be used later in the assembly under Step 15 and 16.

**The second set of measurements is used to determine total end clearance**. To give proper rotor end clearance at both inlet and discharge ends (referred to as total end clearance) the distance between the face of the bearing carriers must be equal to the rotor length plus both end clearances. Total end clearance is obtained by adding shims (27) as required between the flange of the housing and the discharge and bearing carrier. The thickness of the shim set is determined as outlined in Steps 9 and 10.

9. With a depth micrometer (FIGURE 7- 9, page 43), measure the distance from the end of the rotor lobes to the end of the housing. Rotate rotors to check each lobe and record the **largest micrometer reading**. If the measurement varies more than .005", remove the rotors and check for burrs on the gear end carrier face and the end of the rotors. To the largest micrometer reading add the Total End Clearance shown in the clearance chart, (FIGURE 7-8, page 43), plus, .002" for crush fit, to determine the thickness of the shim set.

   EXAMPLE FOR 11CDL31 BLOWER: Micrometer reading of .090" plus .0.051" total end clearance plus .002" for crush gives a shim set thickness of .143".

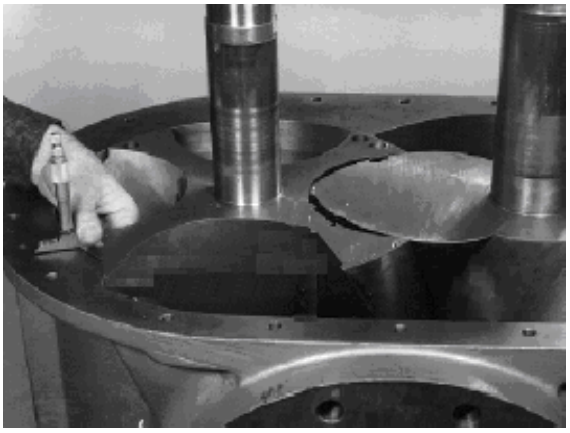


**FIGURE 7- 9 – DEPTH MICROMETER**

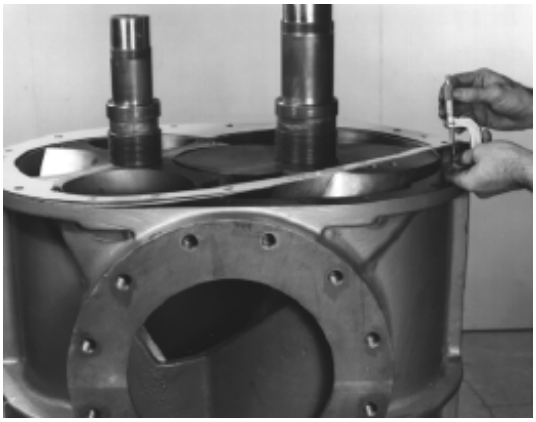


**FIGURE 7-10 – OUTSIDE MICROMETER**

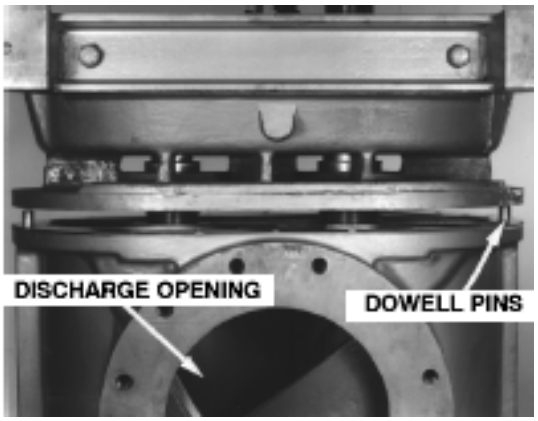



**FIGURE 7-11 – DISCHARGE OPENING**

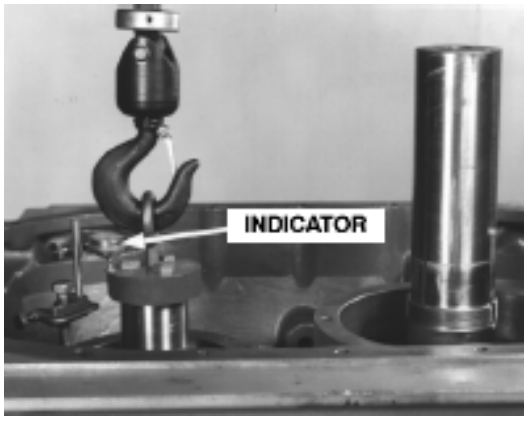



**FIGURE 7-12 – DIAL INDICATOR**

10. Select the correct thickness of aluminum shims (27) to give the shim set established in Step 9. Check the thickness of the shims with an outside micrometer (FIGURE 7-10, page 43). Place the shims on the end of the housing, matching the pointed section of the shims with the contour of the housing. Remove bearing spacers from the discharge end bearing carrier, (FIGURE 7-7, page 42). Apply Loctite 620 to the I.D. of the bearing spacer. Place them over the shaft extensions grooved end toward rotor. Be sure the spacer fits solidly against the rotor. If measurements in Step 8 differ, make sure the bearing spacer is placed over its respective shaft extension to assure proper end clearance of each rotor.

11. Coat the I.D. of the shaft seals (22, 23) in the discharge end bearing carrier with oil. Remove bearings from the carrier. Tag bearings so they will be reassembled in the same bearing bore from which the measurement was made. Match the cavity of the carrier, (FIGURE 7-7, page 42), with the discharge opening of the housing (FIGURE 7-11), and lower the carrier, suspended plumb, in place on the housing. Be careful not to damage I.D. of the shaft seal by the shaft extension. Be sure there are no shaft shims in place during this operation as sharp edges of shims will damage the seals. Tighten the carrier to housing screws (56, 58) evenly to prevent damage to dowel pins.

12. With the dial indicator attached as shown in (FIGURE 7-12), check the total end clearance. Set the indicator on zero and lift the rotor with a hoist until the end of the rotor strikes the face of the discharge end bearing carrier. The reading of the indicator will be the total end clearance and should match dimensions listed in the clearance chart, (FIGURE 7-8, page 43). If the indicator reading differs from the chart and allowable tolerance, repeat Step 9 and 10 as well as check for burrs giving false readings.

| **NOTICE** |
| --- |
| **Due to allowable machining tolerance of the rotor lengths, there may be cases where one rotor will be within limits and the other slightly over or under.** |

13. All internal oil seals are uni-directional lip seals. They must be installed in the correct location and with proper orientation or the oil will be pumped out of the sump, not retained in it. The rotation arrows (stamped on the face of each seal) and the letters for clockwise (CW) rotation or for counterclockwise (CCW) rotation are located on the air side not the oil side, of the seal case.

    These seals have also been color coded so that the seals with the green outside diameter are always for counterclockwise rotation and the seals with red outside diameter are always for clockwise rotation, when viewed from the air side of the seal. The gate rotor seal on the gear end will always be green so if you think of the three **G's G**ate, **G**ear and **G**reen, you will always know where one seal gets installed. After that, the other rotor on the same end has to be of opposite rotation so the main rotor on the gear end would be a red seal. Since the rotation, viewed from the ends of the rotor, must be different from end to end, the inner seal on the discharge end of the main rotor would be green and the seal on the discharge end of the gate rotor would have a red outside diameter. Each of the seals has a dirt lip on the air side which does not have any spiral grooves in the lip. See (FIGURE 7-13, page 45), for installation guidelines.

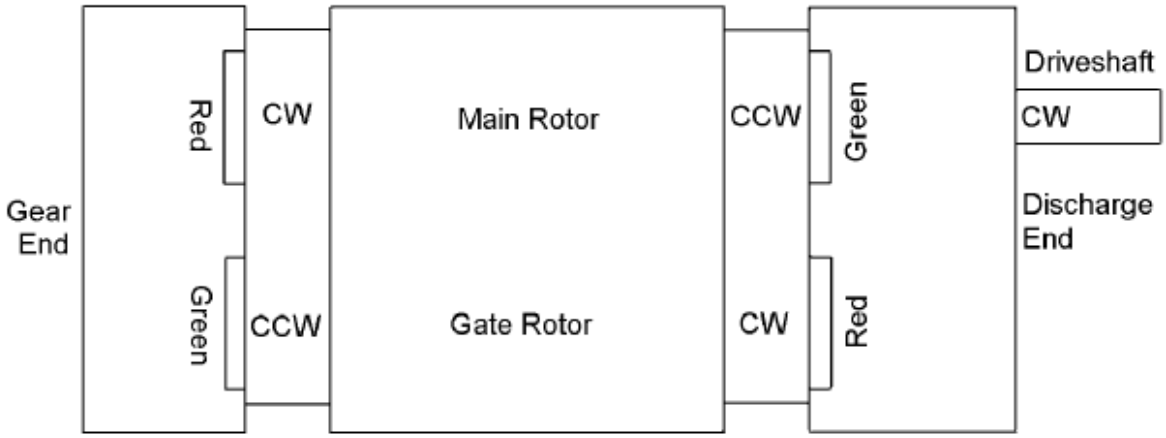



**FIGURE 7-13 – SEAL INSTALLATION GUIDE**

With the hydrodynamic seals, the bearing carrier must be lowered over the shaft first. The installation sleeves **must be used** to cover keyways and to provide smooth transitions onto the diameter changes.

| **NOTICE** |
|---|
| **Seals must stay on the shipping rings until it is time to install them. Otherwise the lips will deform. It is best to store them so the shipping ring is laying on a flat surface.**<br><br>**Never hang a lip seal through the bore.** |

14. Slide the protective installation sleeves over each shaft (Figure 7-14). Install the green outside diameter oil seal (32) on the main rotor shaft and the red outside diameter oil seal (33) on the gate rotor shaft. The dirt lip and the rotation arrow should be down. Drive the seal flush with the bottom of the oil channel cast inside of the bearing bore. Remove installation sleeves and store for later use on the gear end.

15. With micrometer, (FIGURE 7-15, page 46), measure the thickness of shaft shim sets established in Step 5 thru 8. Be sure shims are clean of dirt and oil for true measurement.

16. Check the end of the bearing spacer for dirt and burrs. Be sure the bearing spacer is solid against the rotor. Slide shim set over the shaft extension, (FIGURE 7-15 page 46), up against the end of the bearing spacer.

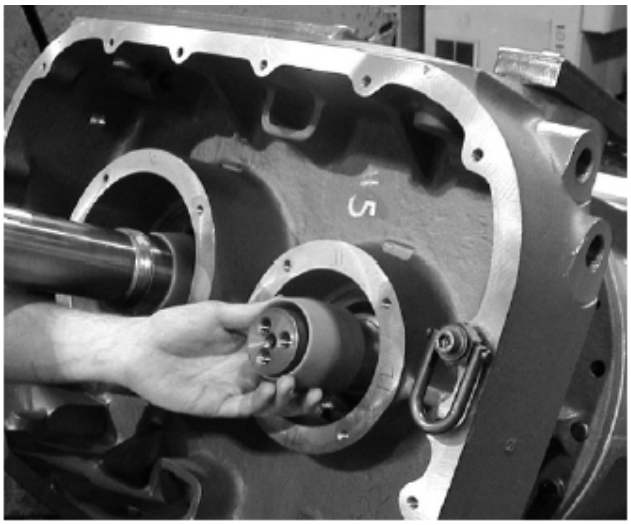


**FIGURE 7-14 – SEAL INSTALLATION GUIDE**

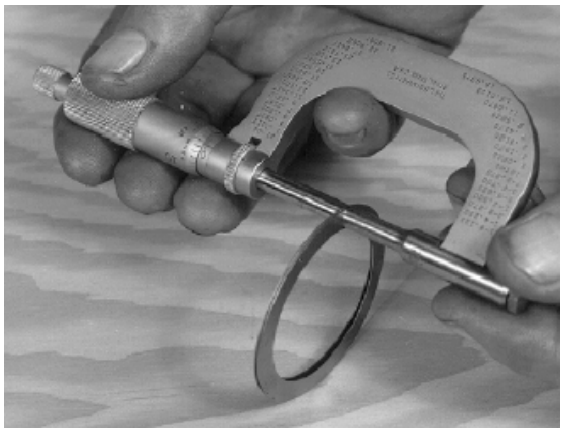


**FIGURE 7-15 – BEARING SHIMS**

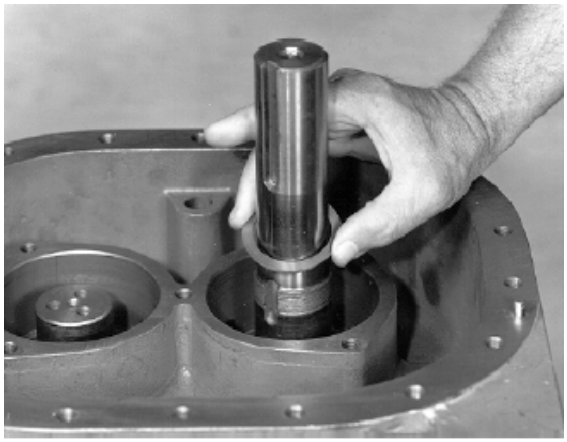


**FIGURE 7-16 – BEARING SHIMS**

17. Lightly coat the shaft extension and bearing bore with oil. Assemble bearings (34, 35), as shown in (FIGURE 7- 5, page 42), on the shaft. Assemble the press plate (refer to FIGURE 6-1, and FIGURE 6-2, Disassembly page 36), on the bearing and install the jack screws, (FIGURE 7-17). Progressively tightening nuts on the jack screws presses bearings in place. To prevent possible damage to the bearings and threads on the shaft, press one bearing over the shaft into the shaft, press one bearing over the shaft into the bore at a time, rather than with both bearings stacked together. When the first bearing is flush with the top face of the bore, the second bearing may be started. Tighten nuts on the jack screws evenly to prevent cocking of the bearings on the shaft and in the bore.

| **NOTICE** |
| --- |
| **It is not recommended to hammer bearings of this size in place.** |

18. Install the bearing clamp plate (14, 16) and four “nylok” type screws, (FIGURE 7-18). Install lock washer (42) and spanner type nut (41) on the main rotor shaft and drive up tight. This operation pulls the rotor shaft through the bearings until the shims and bearing spacer are clamped solidly between the rotor end and bearing, assuring a fixed position of the rotor. **This is an important step in assembly**. The best method for tightening the nuts is with a wrench of the type shown in FIGURE 7-20, Disassembly page 47. Tighten the main rotor nut (41) to 248-375 ft-lb.

    Making sure the bearings are properly seated, measure the height the outer race of the main rotor bearing (34) extends above the bearing carrier surface (4) with a depth micrometer. Measure the height in at least four places around the circumference of the outer race. Establish required shim thickness under the main rotor bearing retainer (16) by taking the average of the measurements and subtracting 0.002” from the average measured height. (Required Shim Thickness = Average Measured Height – 0.002”). Select a maximum of four shims from the shim kit (94) as required to obtain the required calculated shim stack thickness at each screw location. Using a micrometer, measure each stacked thickness to insure the thickness is within +0.000/-0.001 of the required calculated thickness for each screw location. Install main rotor bearing retainer (16) with the required shim stack between the bearing retainer and the bearing carrier at each of the four “Nylok” type screw (67) locations. Tighten screws to 118-140 ft-lb.

    Install bearing retainer plate (14) on the gate rotor with the four “Nylok” type screws (67). Tighten screws to 118-140 ft-lb.

    Install the shaft spacer (15), oil slinger (6) and shaft clamp plate (8) on the gate rotor shaft using three hex head “nylok” type screws (65). (FIGURE 7-20, page 47).

    Be sure the reinforcing plate on the oil slinger is placed up and is located between the oil slinger and shaft clamp plate. Insert enough shim (75) behind the slinger so that the slinger is not distorted when the hex head nylock screws are drawn up tight. This operation pulls the gate rotor shaft through the bearings until the shims and bearing spacer are clamped solidly between the rotor end and bearings, assuring a fixed position of the rotor.

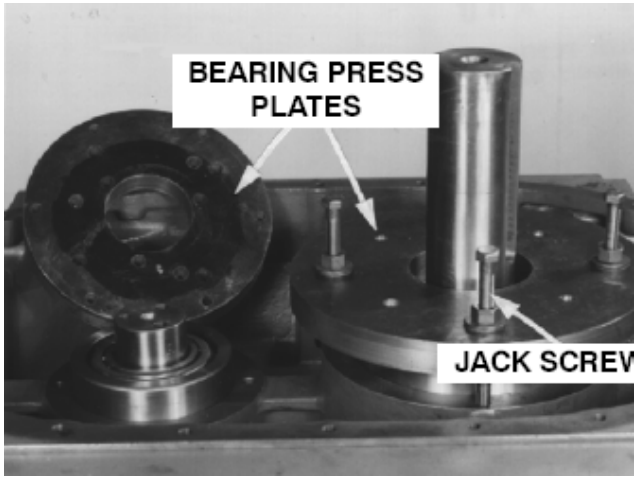



**FIGURE 7-17 – BEARING PRESS PLATE**

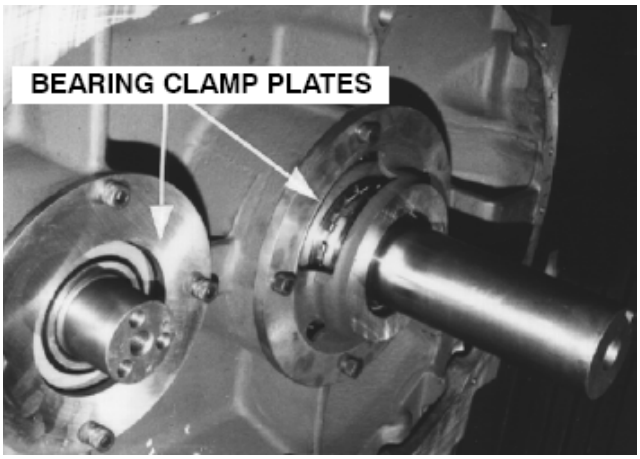



**FIGURE 7-18 – BEARING CLAMP PLATES**

**FIGURE 7-19 – DISCHARGE END CLEARANCE CHECK**

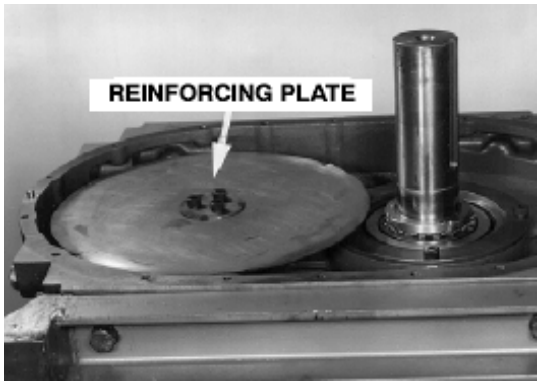



**FIGURE 7-20 – OIL SLINGER**

19. Check the discharge end clearance of the rotor with a feeler gauge through the discharge opening, (FIGURE 7-19, page 47). Also check rotor end clearance at the inlet end through the inlet opening. Clearance should match those listed in the chart, (FIGURE 7-8, page 43), keeping in mind the allowable tolerance and possible .002" variation in rotor lengths. Never allow rotors to run closer than allowable tolerance. Wider clearance will not result in blower failure but may affect efficiency. If the discharge end clearance is too great, make sure the bearing retainer plate is tight, holding the bearing solidly in the bore, and the bearing retainer nuts are tight, which clamp shims and bearing spacer solid against the end of the rotor, Step 18. If clearance is too close, remove the discharge end carrier and repeat the steps to establish shaft shim sets and total clearance.
20. Bend the ear of the lock washer (42) into the slot of the nuts (41) on the main rotor shaft extension. Oil the bearing generously.

21. Check the shaft extension and keyway for burrs. Cover the shaft and keyway with a thin protective installation sleeve. Push the oil seal (31) into the seal adaptor (53). Install the seal adaptor gasket (54), seal and adaptor to the end cover (18) using four screws (70) and two dowels (52). Slide the end cover assembly over the shaft extension FIGURE 7-21 and mount the cover to the bearing carrier with screws (59) and washers (60). Remove the protective installation sleeve. Drive dowels (51) into end cover/bearing carrier holes. Install drive key (49). **The third important measurement** for clearance is to provide for floating bearings at the gear end.

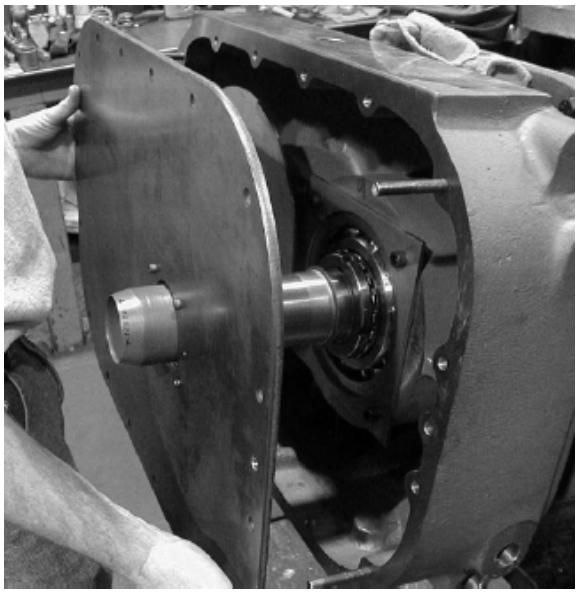


**FIGURE 7-21 – END COVER ASSEMBLY**

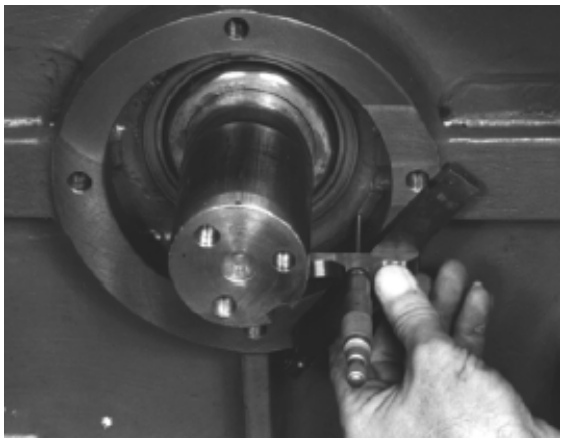


**FIGURE 7-22 – BEARING BORE**

**FIGURE 7-23 – DEPTH MICROMETER**

22. Turn the unit end for end, gear end up. With a depth micrometer on a perfectly flat parallel bar across the bearing bore, measure the distance to the shoulder in the bearing bore, FIGURE 7-22.

23. Remove tape from the shaft holding the bearing spacers in place. Tap the spacer to be sure it is solidly against the end of the rotor. This is important for the next measurement. With a depth micrometer on the same parallel bar used in Step 22, measure the distance to the end of the bearing spacer, (FIGURE 7-23).

24. Slide the protective installation sleeves over each shaft. Install the green outside diameter oil seal (87) on the gate rotor shaft (FIGURE 7-24) and the red outside diameter oil seal (86) on the main rotor shaft. The dirt lip and the rotation arrow should be down. Drive the seal flush with the bottom of the oil channel cast inside the bearing bore. Remove installation sleeves.

25. Slide enough shims (28, 29) over the **main rotor shaft (largest shaft),** (FIGURE 7-25), up against the end of the bearing spacer until the reading is .008" to .013" LESS than the reading in Step 22. This will give .008" to .013" running clearance between the inner race flange and the end of the bearing rollers.

26. Install the roller assembly of the bearing in the bore of the carrier (5) with the numbered side out. The roller assembly is slip fit in the bore. Coat the inner race of the bearing and shaft with oil. **Slide the inner race of the bearing on the shaft with the flange end out.** Assemble the press plate and jack screws as shown and press the inner race over the shaft solidly against the shims and bearing spacer, (FIGURE 7- 26, page 50).

**FIGURE 7-24 – OIL SEAL ON GATE ROTOR SHAFT ASSEMBLY**

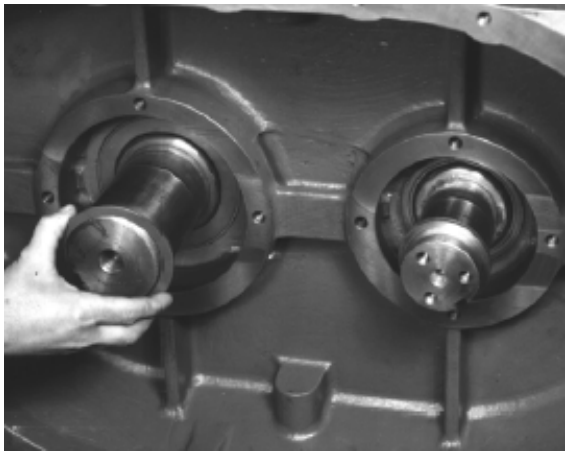


**FIGURE 7-25 – SLIDE SHIMS OVER SHAFT ASSEMBLY**

Tighten the nuts on the jack screws evenly to prevent cocking of the race.

27. Install the bearing clamp plate (12, 13) with “Nylok” type screws (67), (FIGURE 7-27).

    Check the fit of the key (47) in the gear hub (11) and pinion (10). Check the pinion, hub and shaft extensions for burrs. Install the keys in the shafts, making sure of a snug fit. Heat the pinion and hub in oil or dry heat, such as an oven (NEVER USE TORCH) to 350° F, for thirty minutes minimum to allow for complete heat penetration. If heating with oil in a confined area use of cooking oils will prevent undesirable odors.

    Lock the rotors from turning with a piece of hard wood or belting. Install the hub (11) and pinion (10) and pull tight with a locking device, (FIGURE 7-27). Use the hub retainer (7) and screws (68) to pull the hub up tight against the bearing.

    As the hub and pinion cool, check for tightness. The bearing and bearing spacer must be clamped tight against the rotor. Bend the ear of the lockwasher (42) into the slot of the nut (41) holding the pinion. Oil the bearings generously.

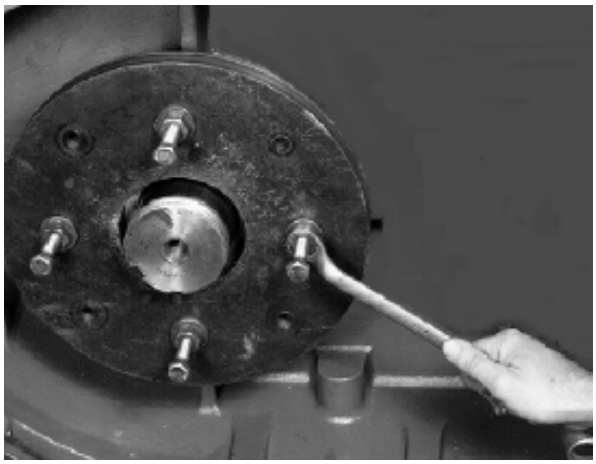


**FIGURE 7- 26 – PRESS PLATE & JACK SCREW ASSEMBLY**

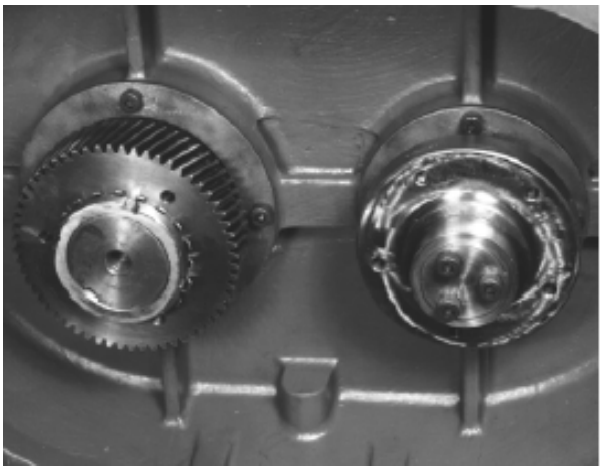


**FIGURE 7-27 – INTALL HUB & PINION PULL TIGHT**

FIGURE 7-28 – SMALLEST MINUS READING

FIGURE 7-29 – SMALLEST PLUS READING

**The final check to be made for running clearances** is dividing the interlobe clearance of the rotors to prevent metal-to-metal contact. This is referred to as "TIMING OF ROTORS" and is accomplished in the following steps.

28. Install the gear (9) on the hub, (FIGURE 7-28, page 51), which is a slip fit. If gear teeth were marked at disassembly, line up these marks. New gears are not marked and should be positioned so tapped holes in the hub are centered with holes in the gear to allow radial movement on the gear for timing. Tighten the "Nylok" screws (69) against the flat washers (66) (always use new washers) just tight enough to allow the gear to slip radially on the hub. Mount an indicator and button bracket as shown in FIGURE 7-28, page 51. In order to accurately follow the next four steps in timing, the indicator must be mounted in a clockwise position from the bracket. The gear has a 3/8-16 tapped hole for indicator support. When the indicator is mounted, hold the gear from rotating and with a wrench in one of the hub retainer screws, move the shaft in a clockwise direction until all slack is taken out of the gears and rotors to give a metal-to-metal contact. To prepare for the first reading, set the indicator at zero.

29. **FINDING SMALLEST MINUS READING** – (FIGURE 7-29, page 51). Hold the gear under clockwise pressure to maintain metal-to-metal contact. Rotate the shaft counterclockwise **two complete revolutions** with a wrench. (Do not rotate by moving the gear.) If at any time the indicator hand moves to the plus side, reset at zero, and again rotate two complete revolutions. Notice the place of the smallest reading (This is the smallest number of thousandths from zero, not the smallest figure on the indicator dial). Continue rotation until the smallest reading is again reached and reset the indicator at zero. This is the closest clearance of rotors in this direction of rotation. If the indicator pointer flutters at any time during rotation, check for burrs or dirt on the rotors or gear teeth.

30. **FINDING SMALLEST PLUS READING** – (FIGURE 7-30). Hold the gear under counterclockwise pressure to take up all slack, and rotate the rotor clockwise **two complete revolutions** with a wrench. Note the place of the smallest plus reading, and continue rotation until the smallest reading is again reached and stop. This is the point of minimum interlobe clearance.

**FIGURE 7-30 – SETTING THE INTERLOBE CLEARANCE**

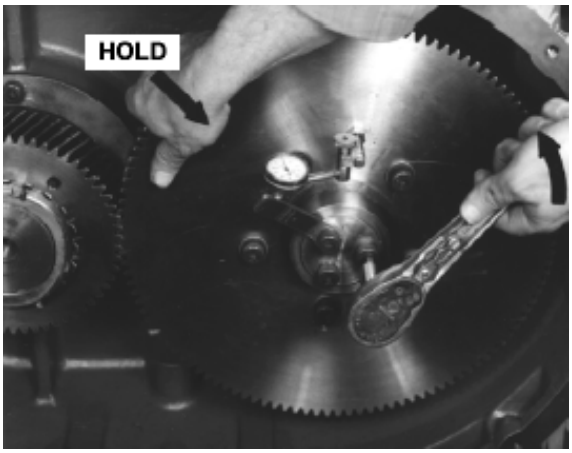



**FIGURE 7-31 – HOLD GEAR & SHAFT FROM TURNING TIGHTEN FIVE GEAR TO HUB**

31. **SETTING THE INTERLOBE CLEARANCE** – (FIGURE 7-31 page 52). The interlobe clearance is divided with 2/3 on the discharge side and 1/3 on the suction side. Hold the gear from turning. Move the shaft counterclockwise with a wrench just enough to obtain 1/3 of the indicator reading obtained is Step 29.

    EXAMPLE: The minimum plus reading in Step 29 is +.018; move the rotor until the indicator reads +.012. This divides the interlobe clearance with 2/3 on the discharge and 1/3 on the suction side.

32. Hold the gear and shaft from turning and evenly tighten four gear to hub “Nylok” screws (69) (FIGURE 7-32). Be sure the indicator reading does not change while tightening the screws. The rotors are held in time by the clamping action of the screws and distortion of the flat washers into the gear holes. Tighten screws securely. Check interlobe clearance to make sure the 2/3 indicator reading is on the discharge side.

    Discharge side clearance is checked with a feeler gauge through the discharge opening in the housing. Rotate the blower several times to be sure timing has not slipped. Recheck the discharge side interlobe clearance and discharge end clearance. When timing is completed remove the indicator, button bracket and gear hub retainer plate. Install the hub retainer plate (7) with pilot in the hub bore with three “Nylok’ type screws (68). Install gasket (30) and carrier cover plate (19). Install breathers (44) on bearing carriers (4, 5).

    Referring to “Lubrication,” page 25, fill the carriers with proper oil. Cover all openings to prevent dirt entering the blower during transportation and installation.

    If the blower is to be stored, refer to “Storage”, page 9.

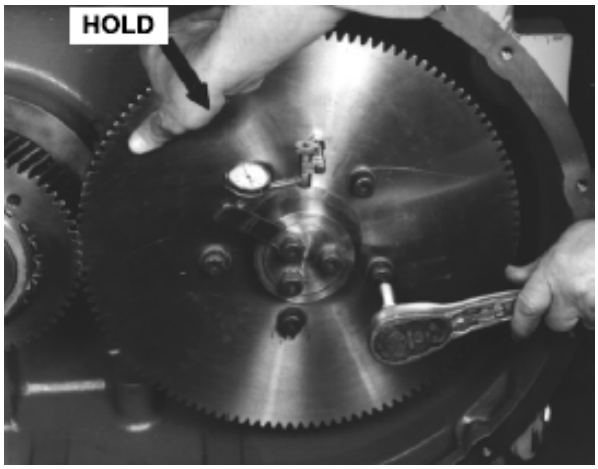



**FIGURE 7-32 – FASTENER TORQUE VALUES**

| FASTENERS & LOCKNUTS (Ref. No.) | | TORQUE VALUES (ft-lb except as noted) |
|---|---|---|
| Locknut | (4) | 248 – 375 |
| Capscrew | (56) | 75 |
| Capscrew | (59) | 38 – 41 |
| Capscrew | (61) | 150 |
| Capscrew | (63) | 150 |
| Capscrew | (65) | 88 - 100 |
| Socket Head Capscrew | (67) | 118 – 140 |
| Socket Head Capscrew | (68) | 110 |
| Socket Head Capscrew | (69) | 118 – 140 |
| Socket Head Capscrew | (70) | 14.5 – 15.5 |

NOTE: (Ref. No.) denotes items shown in drawing on pages 31 & 32.

**FIGURE 7-33 – FASTENERS & LOCKNUT – TORQUE VALUES CHART**

## GENERAL PROVISIONS AND LIMITATIONS

Gardner Denver (the "Company") warrants to each original retail purchaser ("Purchaser") of its new products from the Company or its authorized distributor that such products are, at the time of delivery to the Purchaser, made with good material and workmanship. No warranty is made with respect to:

1. Any product which has been repaired or altered in such a way, in the Company's judgment, as to affect the product adversely.
2. Any product which has, in the Company's judgment been subject to negligence, accident, improper storage, or improper installation or application.
3. Any product which has not been operated or maintained in accordance with normal practice and with the recommendations of the Company.
4. Components or accessories manufactured, warranted and serviced by others.
5. Any reconditioned or prior owned product.

Claims for items described in (4) above should be submitted

## WARRANTY PERIOD

The Company's obligation under this warranty is limited to repairing or, at its option, replacing, during normal business hours at an authorized service facility of the Company, any part which in its judgment proved not to be as warranted with the applicable Warranty Period as follows,

## BARE BLOWERS

Basic bare blowers, consisting of all parts within, are warranted for 12 months from date of initial use or 18 months from date of shipment to the first purchaser, whichever occurs first.

Any disassembly or partial disassembly of the blower, or failure to return the "unopened" blower per Company instructions, will be cause for denial of warranty.

## OTHER COMPONETS

All other components are warranted for 12 months from date of initial use or 18 months from date of shipment to first purchaser, whichever comes first.

All costs of transportation of product, labor or parts claimed not to e as warranted and, of repaired or replacement parts to or from such service facilities shall be borne by the Purchaser. The Company may require the return of any part claimed not to be as warranted to on of its facilities as designated by Company, transportation prepaid by Purchaser, to establish a claim under this warranty.

## LABOR TRANSPORTATION AND INSPECTION

The Company will provide labor, by Company representative or authorized service personnel,
for repair or replacement of any product or part thereof which in the Company's judgment is proved not to be as warranted. Labor shall be limited to the amount specified in the Company's labor rate schedule.
Labor costs in excess of the Company's rate schedule amounts or labor provided by unauthorized service personnel is not provided for by this warranty.

Replacement parts provided under the terms of the warranty are warranted for the reminder of the Warranty Period of the product upon which installed to the same extent as if such parts were original components thereof.

## DISCLAIMER

THE FOREGOING WARRANTY IS EXCLUSIVE AND IT IS EXPRESSLY AGREED THAT, EXCEPT AS TO TITLE, THE COMPANY MAKES NO OTHER WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABLILITY.

THE REMEDY PROVIDED UNDER THIS WARRANTY SHALL BE THE SOLE, EXCLUSIVE AND ONLY REMEDY AVAILABLE TO PURCHASER AND IN NO CASE SHALL THE COMPANY BE SUBJJECT TO ANY OTHER OBLIGATIONS OR LIABILITIES UNDER NO CIRCUMSTANCES HSALL THE COMPANY BE LIABLE FOR SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, EXPENSES, LOSSES OR DELAYS HOWSOEVER CAUSED.

No statement, representation, agreement, or understanding, oral or written, made by any agent, distributor, representative, or employee of the Company which is not contained in this Warranty will be binding upon the Company unless made in writing and executed by an officer of the Company.

This warranty shall not be effective as to any claim which is not presented with 30 days after the date upon which the product is claimed not to have been as warranted. Any action for breach of this warranty must be commenced within one year after the date upon which cause of action occurred.

Any adjustment made pursuant to this warranty shall not be construed as an admission by the Company that any product was not as warranted.

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# Appendix F • Compressed Air and Gas Institute - Mechanical Vibration

COMPRESSED AIR AND GAS INSTITUTE

# Mechanical Vibration – Evaluation of Machine Vibration by Measurements on Non Rotating Parts – Rotary Positive Displacement and Centrifugal Blowers

CAGI / BL 100-2004

Compressed Air and Gas Institute

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CAGI

1300 Sumner Ave
Cleveland, Ohio 44115-2851

COMPRESSED AIR AND GAS STANDARD

# Mechanical Vibration – Evaluation of Machine Vibration by Measurements on Non Rotating Parts – Rotary Positive Displacement and Centrifugal Blowers

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## Foreword

BL 100, *Mechanical Vibration—Evaluation of Machine Vibration by Measurements on Non-Rotating Parts—Rotary Positive Displacement and Centrifugal Blower* has been developed by the Blower Section of the Compressed Air and Gas Institute with the intention of covering general and specific points relative to rotary positive displacement blowers, and single stage or multistage centrifugal blowers not addressed in ISO 10816-1, 1st edition, 12-15-1995 in order to provide clarification on vibration criteria and evaluation.

This standard provides practical information on installation, applications, and vibration readings of blowers. The Compressed Air and Gas Institute recognizes the need to periodically review and update this standard. Suggestions for improvement should be forwarded to the Compressed Air and Gas Institute, 1300 Sumner Ave., Cleveland, OH 44115; E-mail address: cagi@cagi.org.

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**COMPRESSED AIR AND GAS INSTITUTE**

**Mechanical Vibration – Evaluation of Machine Vibration by Measurements on Non-Rotating Parts – Rotary Positive Displacement and Centrifugal Blowers**

## 1. Introduction

It is recognized that manufacturers of rotary positive displacement blowers, or single stage or multistage centrifugal blowers recommend the standard ISO 10816-1, 1st edition, 12-15-1995 to provide the general guideline for vibration criteria and evaluation. However, due to nuances inherent to the above referenced products, there are certain aspects regarding machine vibration measurement and evaluation to which manufacturers of the above referenced products either take exception or provide clarification. It is the intent of this Standard to cover general and specific points relative to rotary positive displacement blowers, and single stage or multistage centrifugal blowers.

## 2. Scope

This standard defines the basis for specifying the rules to be employed in evaluating the mechanical vibration of machines in the operating range of 600 to 30,000 rpm in such a way that comparison is possible with similar measurements obtained from other like machines.

The recommended vibration standard is not intended for bearing and gear diagnostic.

## 3. Installation

For installation of blowers, it is important that special care be taken to avoid resonance in the connected piping system and foundation with normal excitation frequencies (e. g.: 1-2x the running frequency or blade/lobe passing frequency) as such resonance can cause excessive vibration.

$$F = \frac{N \cdot R}{60}$$

Where:

F = Basic rotational frequency in Hertz

N = number of elements passing the discharge port per shaft rotation
- 2-Lobe Rotor = 4
- 3-Lobe Rotor = 6
- Centrifugal/Regenerative = Number of Blades

R = rotational speed of the rotor in RPM

### 3.1 Multiple installations of blowers in a single location

When more than a single blower package is installed in a particular location, each blower package should have an independent foundation that is isolated from the floor, or each blower package should be installed on vibration isolators.

## 4. Measurements

This Standard defines the basis for the rules to be employed in measuring the mechanical vibration of the machinery defined in the scope in such a manner that comparison is possible with similar measurements obtained from equivalent machines.

### 4.1 Measurement Parameters

#### 4.1.1 Frequency Range

This Standard is intended to apply to rotary positive displacement blowers, and single stage or multistage centrifugal blowers operating between 600 RPM (10 Hz) and 30,000 RPM (500 Hz). Vibration monitoring equipment shall measure broadband frequencies between 10 to 1,000 Hz for multi-stage centrifugal blowers and between 10 to 10,000 Hz for single stage centrifugal blowers. For PD blowers, the manufacturer may recommend to expand the frequency range (above 1,000 Hz), depending on the blower gear mesh frequency. For example, blowers fitted with gears having 60 teeth and operating at 1800 RPM may generate gear mesh frequencies of 1800, 3600 or 5400 Hz. Expanding the frequency range will ensure proper coverage of the gears, but could result in unreliable readings and must be carried out with care. For readings above 1,000 Hz, the vibration pick-up must be attached securely.

#### 4.1.2 Measurement Quantity

For the purposes of this Standard, the following can be used:

**4.1.2.1** *Vibration displacement*, measured in either mils (thousandths of an inch) or micrometers. Since this standard applies to housing vibration measurement, vibration velocity is preferred to displacement. Displacement is generally applicable to shaft vibration measurements where fluid film type bearings are used.

**4.1.2.2** *Vibration velocity*, measured in either inches per second or millimeters per second. Velocity measurement is an attractive mode of vibration measurement over a wide speed range, (1000 RPM to 10,000 RPM). Vibration velocity is a form of energy. It has been shown that if one inch per second of vibration velocity is damaging at 10,000 RPM, it is also damaging at 1000 RPM. This means that we no longer need be concerned about the speed of the machine we are monitoring. It is therefore possible to set a vibration limit on the monitor

which will be good for a wide range of speeds. It is then only necessary to determine what magnitude of velocity is damaging.

Vibration acceptance criteria listed in Appendix B are only expressed in vibration velocity, both RMS and Peak, mm/sec and inches/sec.

### 4.1.3 Vibration Magnitude

In many cases, it is customary to measure vibration velocity with instruments scaled to read peak-to-peak rather than RMS vibration values. These readings are unfiltered values.

If the vibration waveform is sinusoidal and a single harmonic (single frequency), a simple relationship exists between the peak and RMS values. RMS is equal to half of the square root of two times the peak value (RMS = 0.707 x peak).

It is important to warn the reader that such simple conversion can only be performed for single harmonic vibration signal (like in a spectrum analysis). In the case of mechanically complex rotating equipment, parts in rotation will generate a multitude of frequencies that will superimpose and form a non-harmonic vibration signal. The relationship between Peak vibration velocity and RMS vibration velocity, as explained above, is a rough approximation when dealing with non-harmonic, broadband vibration and the reader should use unfiltered vibration reading with care. Vibration velocity guidelines of Appendix B are given for reference only.

Modern vibration instruments are capable of measuring broadband RMS vibration velocity, which is the preferred way of analyzing broadband, non-harmonic signals. RMS vibration velocity can be related to the vibration energy. The reader can refer to ISO standard 10816-1 (paragraph 3.1.2, 3.1.3 and Annex A) for more details on this topic and justification for using RMS instead of Peak units.

### 4.1.4 Vibration Severity

The severity chart in Appendix B and classifications are not intended to serve as acceptance specifications. Acceptance criteria are subject to agreements between the machine manufacturer and the customer; however, these values provide guidelines for insuring that gross deficiencies or unrealistic requirements are avoided. In such cases, there may be specific features associated with an individual machine that would require different zone boundaries, either higher or lower, to be used. When use of a zone boundary that results in a higher degree of vibration than specified in the severity chart and classification, it is the responsibility of the machine manufacturer to explain clearly to the customer the reason for such deviation, and confirm that operation of the machine in question under the deviation is not detrimental to its long-term operation.

The severity chart in Appendix B is based on equipment rigidly mounted, or grouted to its support foundation (as described in Appendix A2). If a machine is resilient mounted (as described in Appendix A1 and A3), it is acceptable that the allowable vibration measured on the machine itself can be up to twice that specified in the severity chart.

## 4.2 Measuring Positions

Measurements shall be taken using the type of probe, frequency bands and at the locations shown on the Appendix applicable to the type of machine. Values recorded on the appropriate Vibration Data Recording Sheet in Appendix C shall be compared to the severity chart in Appendix B.

Appendix C1 applies to rotary positive displacement blowers.

Appendix C2 applies to multi stage centrifugal blowers.

Appendix C3 applies to single stage centrifugal blowers.

Appendix C4 applies to general operating data.

## APPENDIX A1

## TYPICAL RESILIENT MOUNTED BLOWER PACKAGE ON A COMMON CONCRETE SLAB

A foundation design is very important to insure the proper installation and life equipment. The size of machine and package generally dictate the foundation required. Consult the equipment manufacturer for specific requirements.

### CONCRETE SLAB

(Generally recommended for PD machines.)

When possible, pour directly on the ground with a raised portion of a minimum of 6" high and, at least 6" exceeding the overall base dimensions. The surface should be leveled and smooth to mount the package directly. The mass slab should be, if possible, 1.5 times the weight of the blower package.

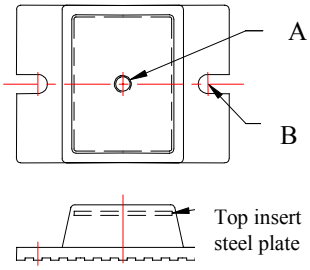
Before setting the machine on the foundation, the parts in contact with concrete must be cleaned of any oil or grease traces. When installing the blower (base) on the concrete foundation, insert shims between the foundation and the elastic pads, if required, to accommodate any uneven surface of concrete.

**NEVER INSERT SHIMS BETWEEN THE BLOWER AND BASE PLATE TO CORRECT ANY LEVELING DEFECTS.**

### TYPICAL RESILIENT MOUNTED PD MACHINE

See Figures A1-1 and A1-2

1. Elastic pads under the base plate and bolt to the base plate.
2. Holes in the concrete.
3. Suitable anchor bolts to be tightened firmly.
4. Isolation. (Elastomer) (does not isolate the concrete slab from the rest of the building)




A: Tapped hold for mounting to base-plate

B: Drill holes for mounting to bearing surfaces using Hilti-type anchor bolts.

Fig. A1-1

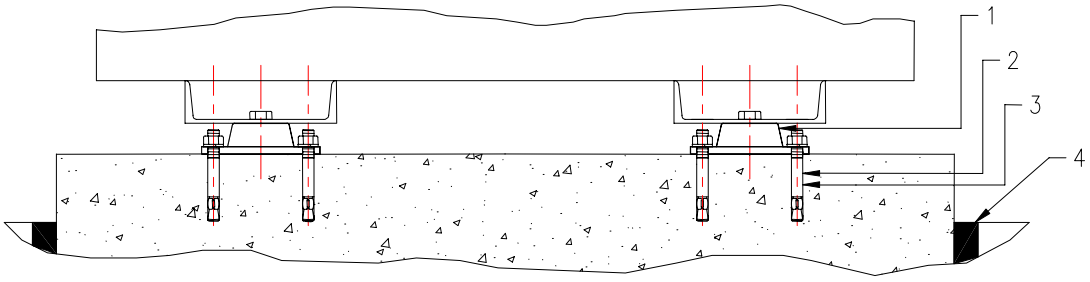



Fig. A1-2

# APPENDIX A2
# TYPICAL RIGID MOUNTED MACHINE

**INSTALLATION ON AN ISOLATED CONCRETE FOUNDATION**
(Generally recommended for machines 250 HP and up).

This type of foundation isolates the machine from the rest of the building and reduces vibration transmission to the structure and other equipment.

The concrete base mass should be equivalent to 1.5 times the weight of the equipment. A ½" (12 mm) cork or elastomer is used for isolation between the isolated concrete foundation pad and the rest of the building.

The use of anchor bolts, commonly used for machinery with relatively high installed power, involves the use of a concrete foundation isolated from the rest of the building to prevent the transmission of vibration.

Where anchor bolts are used, the base-plate shall be fitted in accordance with the following instruction:

- The surfaces shall be left rough so as to provide a better adhesion for grouting (which is carried out subsequently).
- All surfaces are to be levelled transversally and longitudinally as specified.
- Install the blower package on the concrete pad and level it properly using the levelling screws provided. The levelling screws should rest on metal plates, not directly on the concrete pad. Leave sufficient gap between the blower skid and the concrete pad to allow for proper grouting. Follow the grout manufacturer's recommendations.
- Clean the surfaces of the pad and prepare it for grouting. Provide an enclosure as shown in Figure A2-1. Pour grout under the base to the level indicated in Figure A2-1. Avoid the use of mechanical vibrators so as not to disturb the level surface obtained. Instead, promote grout with the use of bars or chains.
- Cure the grout adequately for an appropriate number of days.
- Drill the holes as per the anchor bolt manufacturer's recommendation. Install the suitable anchor bolts, to be tightened firmly, when the equipment is settled. Loosen the leveling screws.
- Size of anchor bolts and leveling screws are indicated on the general arrangement drawing from equipment manufacturer.

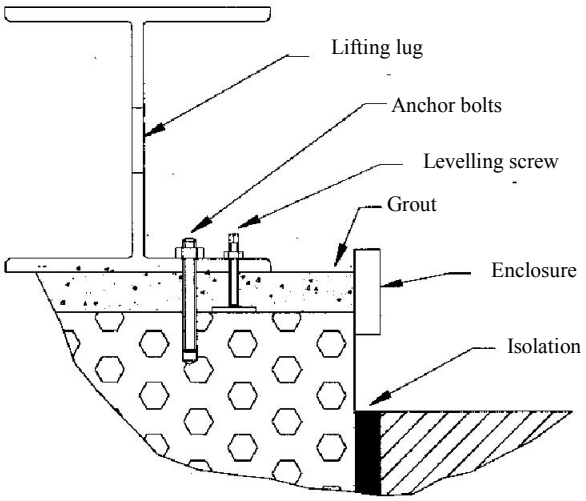



Figure A2-1

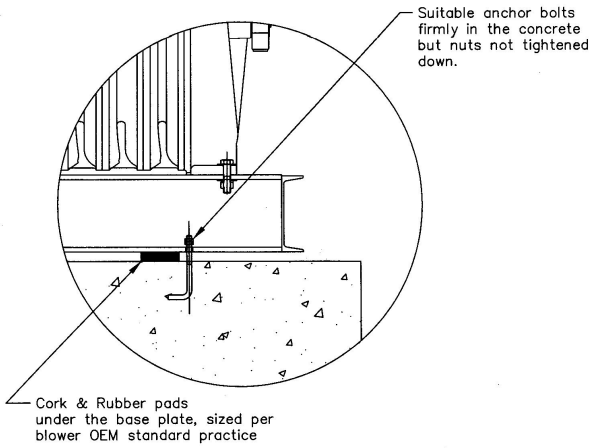
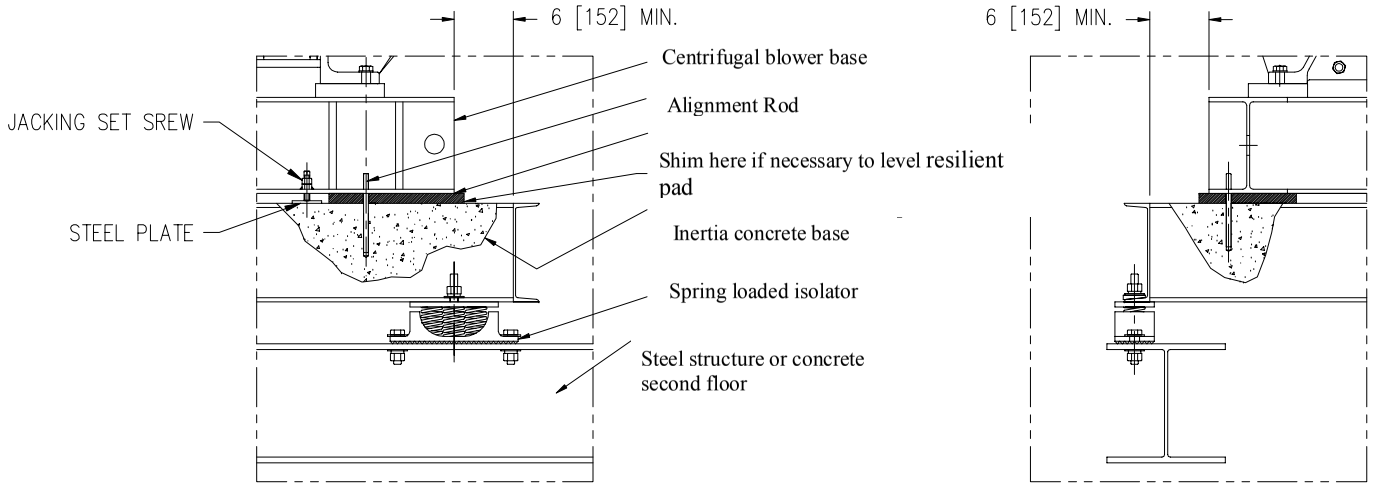



Figure A2-2

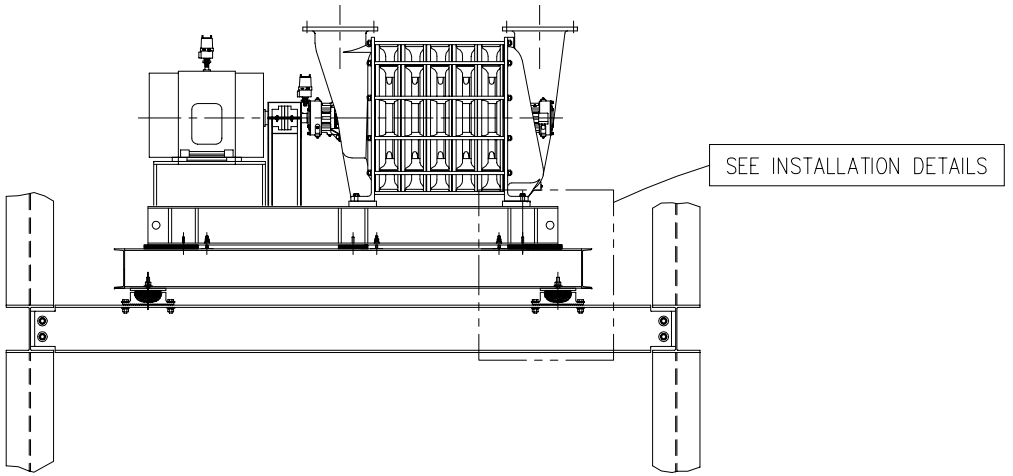
Typical Centrifugal Blower Mounting

## APPENDIX A3

### TYPICAL RESILIENT MOUNTED BLOWER PACKAGE ON A STEEL STRUCTURE OR A BUILDING SECOND FLOOR (multi-stage blower represented)




Note: Inertia concrete base recommended weight should be equal to a minimum of ½ to 1 ½ times if possible the weight of the machinery (package)



# APPENDIX B

# Vibration severity ranges and examples of their application

FASTENED TO A LARGE AND RIGID FOUNDATION AS DEFINED IN APPENDIX A.

| Range of vibration severity | | | Examples of quality judgment for separate classes of machines | |
|---|---|---|---|---|
| Range | Velocity at the range limits in mm/sec **(in inch/sec)** | | Single or Multi-stage | Rotary Positve Displacements |
| | **RMS** | **PEAK** | | |
| 0.28 **(0.011)** | 0.28 **(0.011)** | 0.40 **(0.016)** | A & B | A & B |
| 0.45 **(0.017)** | 0.45 **(0.017)** | 0.64 **(0.024)** | | |
| 0.71 **(0.028)** | 0.71 **(0.028)** | 1.00 **(0.040)** | | |
| 1.12 **(0.044)** | 1.12 **(0.044)** | 1.58 **(0.62)** | | |
| 1.80 **(0.071)** | 1.80 **(0.071)** | 2.55 **(0.10)** | | |
| 2.80 **(0.110)** | 2.80 **(0.110)** | 3.96 **(0.16)** | | |
| 4.50 **(0.177)** | 4.50 **(0.177)** | 6.36 **(0.25)** | C | |
| 7.10 **(0.280)** | 7.10 **(0.280)** | 10.0 **(0.40)** | | C |
| 11.2 **(0.441)** | 11.2 **(0.441)** | 15.84 **(0.62)** | D | |
| 18.0 **(0.709)** | 18.0 **(0.709)** | 25.46 **(1.00)** | | |
| 28.0 **(1.102)** | 28.0 **(1.102)** | 39.60 **(1.56)** | | D |
| 45.0 **(1.772)** | 45.0 **(1.772)** | 63.64 **(2.51)** | | |
| 71.0 **(2.795)** | 71.0 **(2.795)** | 100.41 **(3.95)** | | |

**A or B: Acceptable**

**C: Further evaluation may be required. Contact manufacturer.**

**D: High concern for machine damage. Discontinue operation and contact manufacturer.**

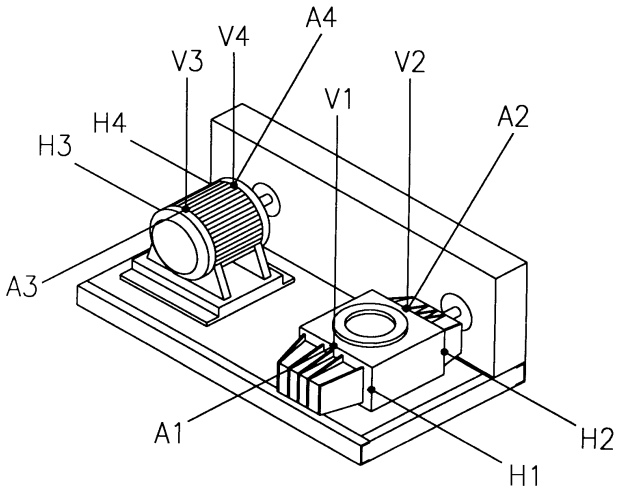
## APPENDIX C1

### Vibration data recording sheet
### Positive Displacement blowers

**Vibration readings**

Use a magnetic accelerometer probe up to 1000 Hz. See 4.1.1 for higher frequencies
The frequency bands measured are 10 to 1000 Hz (Refer to 4.1.1) and the results are in RMS or PEAK velocity.
Measuring points shown are presented on figure below.
The values shall be compared with the table in Appendix B.

Measurement Locations




A: Axial
H: Horizontal
V: Vertical

| Vibration Unit ☐ mm/sec ☐ in/sec | Blower I.D.: S/N: Motor S/N: | | Blower I.D.: S/N: Motor S/N: | | Blower I.D.: S/N: Motor S/N: | |
|---|---|---|---|---|---|---|
| | RMS | PEAK | RMS | PEAK | RMS | PEAK |
| A1 | | | | | | |
| H1 | | | | | | |
| V1 | | | | | | |
| A2 | | | | | | |
| H2 | | | | | | |
| V2 | | | | | | |
| A3 | | | | | | |
| H3 | | | | | | |
| V3 | | | | | | |
| A4 | | | | | | |
| H4 | | | | | | |
| V4 | | | | | | |

Comments: _____

| **Measuring Instruments used** | |
|---|---|
| Vibration meter: | Calibration date: |
| Inst. No.: | Calibration date: |

Technician Date:

## APPENDIX C2

### Vibration readings

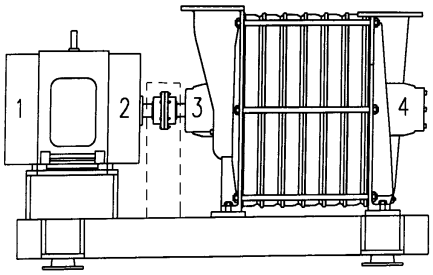
Use a piezo accelerometer probe.

Measure waveband range from 10 to 1000 Hz and the results are shown in RMS or PEAK velocity.

Measuring points are shown on figure below.

Vibrations readings shall be compared to ISO 10816.1 standards severity chart

Measuring points




A: Axial
H: Horizontal
V: Vertical

| Vibration Units ☐ mm/sec ☐ in/sec | Blower I.D.:_____Speed:_____ S/N: _____ Motor S/N: | | | Blower I.D.:_____Speed:_____ S/N: _____ Motor S/N: | | | Blower I.D.:_____Speed:_____ S/N: _____ Motor S/N: | | |
|---|---|---|---|---|---|---|---|---|---|
| | RMS | | PEAK | RMS | | PEAK | RMS | | PEAK |
| A1 | | | | | | | | | |
| H1 | | | | | | | | | |
| V1 | | | | | | | | | |
| A2 | | | | | | | | | |
| H2 | | | | | | | | | |
| V2 | | | | | | | | | |
| A3 | | | | | | | | | |
| H3 | | | | | | | | | |
| V3 | | | | | | | | | |
| A4 | | | | | | | | | |
| H4 | | | | | | | | | |
| V4 | | | | | | | | | |

Notes: _____

_____

| **Measuring instruments used** | |
|---|---|
| Vibration meter: | Calibration - date: |
| Inst. no: | |

Technician: _____ Date: _____

## APPENDIX C3

### Vibration readings

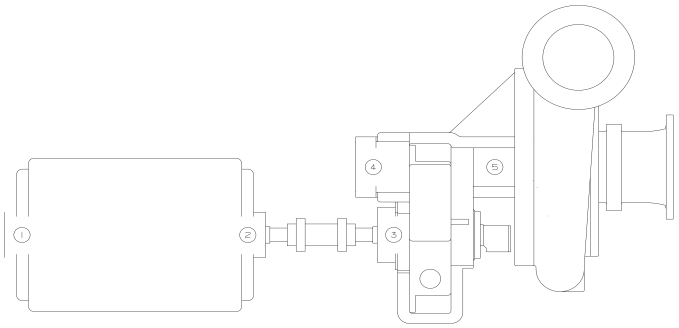
Use a piezo accelerometer probe.

Measure waveband range from 10 to 1000 Hz and the results are shown in RMS or PEAK velocity.

Measuring points are shown on figure below.

Vibrations readings shall be compared to ISO 10816.1 standards severity chart

Measuring points




A: Axial
H: Horizontal
V: Vertical

| Vibration Units ☐ mm/sec ☐ in/sec | Blower I.D.:_____Speed:_____ S/N: _____ Motor S/N: | | | Blower I.D.:_____Speed:_____ S/N: _____ Motor S/N: | | | Blower I.D.:_____Speed:_____ S/N: _____ Motor S/N: | | |
|---|---|---|---|---|---|---|---|---|---|
| | RMS | | PEAK | RMS | | PEAK | RMS | | PEAK |
| A1 | | | | | | | | | |
| H1 | | | | | | | | | |
| V1 | | | | | | | | | |
| A2 | | | | | | | | | |
| H2 | | | | | | | | | |
| V2 | | | | | | | | | |
| A3 | | | | | | | | | |
| H3 | | | | | | | | | |
| V3 | | | | | | | | | |
| A4 | | | | | | | | | |
| H4 | | | | | | | | | |
| V4 | | | | | | | | | |
| A5 | | | | | | | | | |
| H5 | | | | | | | | | |
| V5 | | | | | | | | | |

Notes: _____

_____

| **Measuring instruments used** | |
|---|---|
| Vibration meter: | Calibration - date: |
| Inst. no: | |

Technician: _____ Date: _____

## APPENDIX C4

**Field readings**

Blower Name plate - Serial number: _____

Motor Name plate - Serial number: _____

Control Panel - Serial number: _____

HP: _____ RPM: _____ PH: _____ V: _____ HZ: _____

INSL: _____ S.F. _____ Frame: _____ Eff.: _____ FLA: _____

| | | | | | |
|---|---|---|---|---|---|
| **Percentage operation** | | | | | |
| **Sheave Dia.** | Blower | | | | |
| | Motor | | | | |
| **RPM** | Blower | | | | |
| | Motor | | | | |
| **Voltage** | V (1 - 2) | | | | |
| | V (2 - 3) | | | | |
| | V (1 - 3) | | | | |
| **Current** | A1 | | | | |
| | A2 | | | | |
| | A3 | | | | |
| **Pressure** ☐ Psig ☐ Kpa ☐ In Hg | | | | | |
| **Temperature** ☐ °C ☐ °F | Inlet | | | | |
| | Outlet | | | | |
| **Relief valve Pressure setting** ☐ Psig ☐ Kpa ☐ In Hg | | | | | |
| **Indoor temperature** ☐ °C ☐ °F | | | | | |
| **Barometric pressure** ☐ psia ☐ Kpa | | | | | |
| **Relative humidity (%)** | | | | | |
| **Number of hours running time** | | | | | |
| **Instruments used** | | Ammeter | Voltmeter | Tachometer | |
| Date of calibration: | Inst. no.: | | | | |

Technician: _____ Date: _____

# Appendix G • Oil Pressure Switch Adjustment Instructions

Barksdale
CONTROL PRODUCTS

Barksdale, Inc.
3211 Fruitland Avenue
Los Angeles, CA 90058
(323) 589-6181
(323) 589-3463
e-mail: sales@barksdale.com
www.barksdale.com

# ADJUSTMENT INSTRUCTIONS

## Differential/Pressure/Vacuum Switch

**General:**

1. Check proof pressure of switch on name plate or catalog. ***NEVER EXCEED THIS PROOF PRESSURE.***
2. Note the adjustable range of switch (increasing or decreasing pressure) as listed in the catalog or on the name plate.
3. Check the catalog listing for actuation value of the switch.

To set the switch you need: 1. A pressure/vacuum source
2. A pressure/vacuum gauge
3. An electric continuity tester

**CAUTION! -ALWAYS CHANGE PRESSURE SETTING GRADUALLY.**
**-ALWAYS check switch setting before making any adjustments.**

Step 1**.** Determine if the pressure/vacuum set point is on increasing or decreasing pressure.

Step 2. If the set point is on increasing pressure, then decrease the pressure/vacuum of the source starting at a point lower than the set point. Use maximum 1/4 turn on adjustment screw.

If the set point is on decreasing pressure, then increase the pressure/vacuum of the source starting at a point higher than the set point.

Step 3. Using the continuity tester and the pressure/vacuum gauge determine the actuation point of the switch.

Step 4. If the actuation point is above the desired value, turn the adjustment screw or knob per instructions in the pressure switch catalog to increase the actuation point, and if it is below, turn the adjustment screw or knob in the opposite direction to decrease it.

Step 5. For exact pressure/vacuum setting, cycle pressure/vacuum switch and make fine adjustments by repeating steps 2 through 4 (trial and error process) until the desired setting is obtained.

Note 1. For proper electrical connection follow colors of wire insulation or instructions on terminal code tag attached to switch.
Note 2. Dual control switches should be set one side at a time. Recheck both sides after final setting.

**CAUTION! -DO NOT** force adjustment screw when it becomes difficult to turn.

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