KINNEY® KMBD™ SERIES
Mechanical Vacuum Boosters

Models 2900 3600 4500

INSTALLATION
OPERATION
MAINTENANCE
REPAIR
MANUAL

WARNING

DO NOT OPERATE
BEFORE READING MANUAL

ISO 9001

05/2009

Tuthill®

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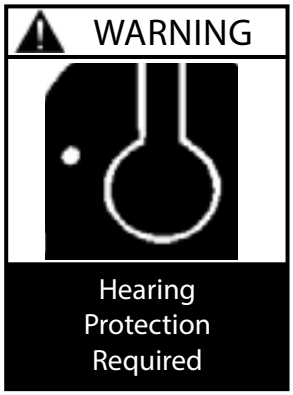
SAFETY INSTRUCTIONS

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.

NOTICE

1. The safety instruction tags shown below were attached to your unit prior to shipment. Do not remove, paint over, or obscure in any manner.
2. Failure to heed these warnings could result in serious bodily injury to the personnel operating and maintaining this equipment.



SAFETY WARNINGS

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

TUTHILL VACUUM AND BLOWER SYSTEMS — SPRINGFIELD, MO USA

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 register your product online at:

http://www.tuthill.com/us/en/about/organization/lob/vacuum/product-registration.cfm

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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:

- Booster casing and associated piping or accessories may become hot enough to cause major skin burns on contact.
- Internal and external rotating parts of the booster and driving equipment can produce serious physical injuries. Do not reach into any opening in the booster 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.
- 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.

TABLE OF CONTENTS

INTRODUCTION

This manual covers the installation, operation and maintenance of KMBD 2900, 3600, and 4500 mechanical vacuum boosters. See the table below for features pertaining to individual series products.

The boosters are manufactured for either a vertical flow or a horizontal flow. Most in-field drive conversions can be readily accomplished by changing the location of a few external parts. Water cooled end plates are optional on all units.

IMPORTANT: Record the booster model and serial numbers of your machine in the OPERATING DATA form on the inside back cover of this manual. 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 CHARACTERISTICS

The Tuthill KMBD 2900, 3600, and 4500 mechanical vacuum boosters are positive displacement type units, whose pumping capacity is determined by size, operating speed, and differential pressure conditions. Both blowers and vacuum boosters employ dual-lobe rotors rotating in opposite directions within a housing that is closed at the ends by end plates.

Effective sealing of the inlet to the discharge is accomplished through the use of very small operating clearances. The resulting absence of moving contact eliminates the need for any internal lubrication. Clearances between the rotors during rotation are maintained by a pair of accurately machined helical timing gears, mounted on the two shafts extended outside the air chamber. The two intermeshing rotary lobes are designed to rotate and trap air or gas between each rotor and the housing. As the rotor lobes rotate past the edge of the suction port, the trapped air or gas is essentially at suction pressure and temperature. Since the blower is a constant volume device, the trapped air remains at suction pressure until the leading rotor lobe opens into the discharge port. The close clearances between the rotors inhibit back slippage of the trapped volume from between the rotors and the trapped volume is forced into the discharge piping. Compression occurs not internal to the blower, but by the amount of restriction, either downstream of the blower discharge port, or upstream of the blower inlet port.

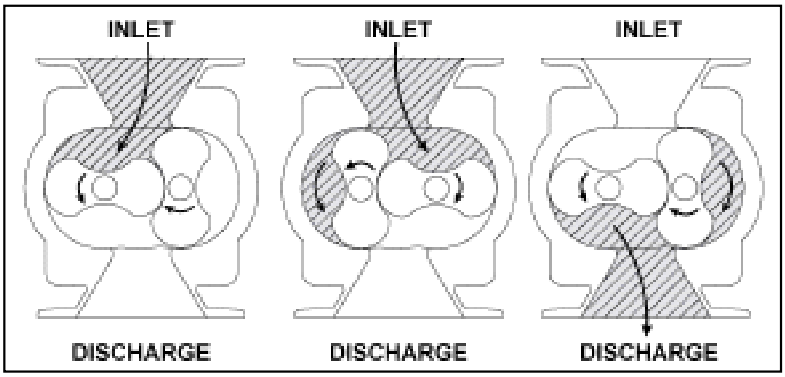


Figure 1 . Illustration of general operation principle

Figure 1 illustrates that the air moves not between the rotors but between the rotors and the side of the housing. Also, the machine is bi-directional, meaning that the rotational direction of the blower can make either side the inlet or discharge. See also Figure 2, Flow Direction by Rotation.

Vacuum boosters must be protected by cut-in switches or with bypass valving to limit differential pressure across the booster. This is described in greater detail in the Operating Limitations - Vacuum Boosters section, below.

When a belt drive is employed, blower speed, if necessary, can usually be adjusted to obtain desired capacity by changing the diameter of one or both sheaves, or by using a vari-speed motor pulley.

SERIES AND FEATURES

PRODUCT TYPE		DRIVE SHAFT SEAL		INTERNAL SEALS		LUBRICATION		
SERIES	FLOW DIRECTION	MECHANICAL SEAL	LIP SEAL	LABYRINTH/ LIP SEALS	LABYRINTH/ MECHANICAL SEALS	SPLASH LUBE	INTEGRAL LUBE	EXTERNAL LUBE
31	Vertical	X	X		X		X	
33	Horizontal	X	X		X		X	
90	Vertical	X	X		X	X		
91	Horizontal	X	X		X	X		

OPERATING LIMITATIONS FOR VACUUM BOOSTERS

To permit continued satisfactory performance, a vacuum booster must be operated within certain approved limiting conditions. The manufacturer's warranty is also contingent on such operation. Maximum limits for pressure, temperature, and speed are specified here for various blower sizes when operated under the standard atmospheric conditions. Do not exceed any one of these limits.

Example: Seldom is the operation of a vacuum booster result in pressure differentials large enough to strain the blower drive train (bearings, gears, and seals). Typically in vacuum boosting, the maximum allowable temperature limit (the limit is a function of the

temperature rise as well as the inlet temperature) for any particular booster may occur well before the maximum speed or allowable power rating is reached. Temperature rise then becomes the limiting condition. In other words, the operating limit is always to be determined by the maximum rating reached first, and it can be any one of the three: temperature, speed, or horsepower.

Note: Special attention must be paid when a vacuum booster has a higher than standard ambient suction temperature. Special recommendations for operating parameters and/or additional cooling may be recommended. Consult the factory or local representative for appropriate information.

Deep vacuum requires instrumentation much more sensitive than standard thermometers and mercury type pressure or vacuum gauges. At operation pressures less than 100 Torr (mmHg), low-deadband cut-in switches and low-mass thermocouples should be utilized and positioned such that the sensor is connected to the inlet and discharge connections of the vacuum booster. NPT connections are provided at each of the inlet and discharge ports for this purpose. Standard temperature switches, because of their higher mass, do not have reaction times fast enough to adequately protect the vacuum booster. Likewise, standard vacuum switches are not recommended for cut-in switches as vacuum boosting typically requires a very accurate cut-in point. A tachometer will enable periodic checks of operating speed.

Note: Specially ordered boosters with non-standard construction, or with rotor end clearances greater than shown on the exploded view drawings, will not have the operating limits specified here. Contact your Tuthill Vacuum & Blower Systems sales representative for specific information.

MODEL	SERIES	PORT SIZE INCHES / mm	APPROX. OIL CAPACITY QUARTS / LITERS		MAXIMUM ALLOWABLE DISCHARGE TEMPERATURE	MAXIMUM DESIGN VACUUM EXHAUSTING in. Hg / mbar	MAX. RPM
			VERTICAL FLOW	HORIZONTAL FLOW			
2900	90/91	10 / 250	8.0 / 7.5	5.0 / 4.75	375° F / 190° C	15 / 505	3000
3600		12 / 300					
4500		12 / 300					

INSTALLATION

Install unit in a protected indoor location, if possible. However, an unprotected outdoor installation will be satisfactory if correct lubrication for expected temperatures is provided (see recommended lubrication section). Just before starting the installation, remove plugs or covers from inlet and discharge connections. Inspect for dirt or foreign objects inside machine, then turn drive shaft by hand to make sure it rotates freely. Mount in a level position. Use of a rigid, solidly supported, structurally sound baseplate is recommended. Make sure feet rest evenly on the plate before fastening down. Twisting or cramping the blower in mounting will cause rotor contact and binding during operation. This condition is known as "soft foot", and prevention of a soft foot condition is described in detail on page 6.

A unit that is factory mounted on a base, should not require the above adjustments. However, since the assembly can become twisted in shipping or installation, checking for soft foot should be done after installation of the base. Shims may be needed for alignment. Loosen the foot hold-down screws to check foot contact with the mounting surface. The base should be mounted on a solid foundation or heavy flooring, using shims as necessary at bolting points to prevent warping the assembly.

Transmission of small operating vibrations to a support structure may be objectionable in some cases. Use of vibration isolators or vibration absorbing materials can be effective in overcoming this problem. To avoid casing distortion, the treatment used should be applied under the motor-blower common mounting plate or base, rather than directly under the feet alone. Piping should be accurately squared with the blower and supported independently. Use only clean new pipe and make certain it is free of scale, cuttings, weld beads, dirt, or any other foreign material. To guard against damage to the blower, insure that an inlet filter is used. Make provisions to clean the filter of collected debris after a few hours of operation and periodically thereafter.

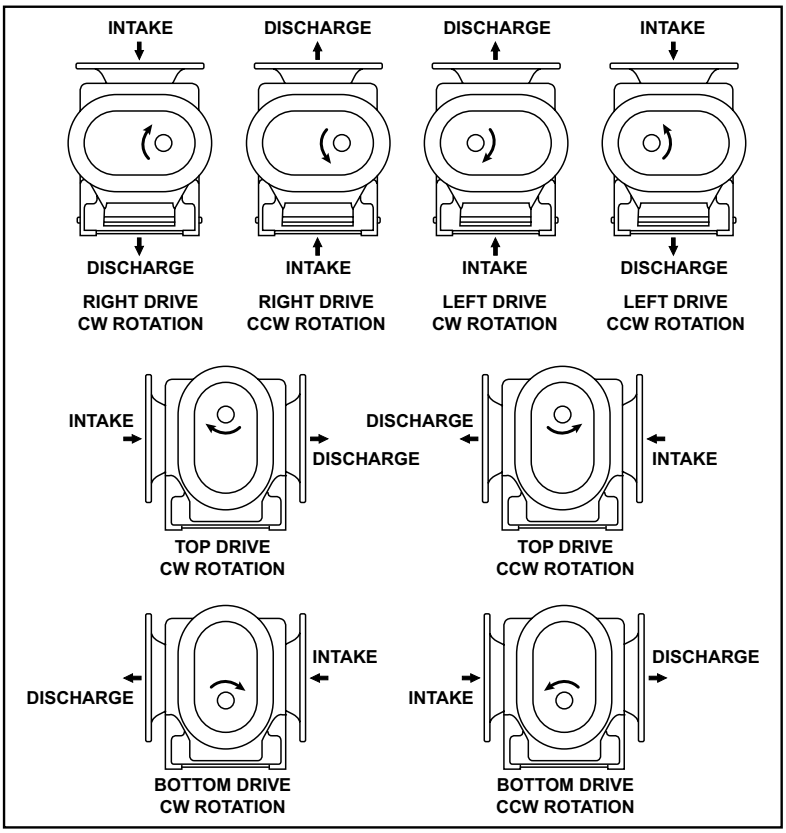


Figure 2 - Flow Direction by Rotation

Weight of accessories and piping must be kept to a minimum to prevent blower casing distortion. Weights in excess of 10% of booster weight should be supported independently of booster and connected with a flexible hose or connectors. A booster may be driven by direct coupling to the driver or by v-belt drive to obtain other speeds within the approved range. Coupling halves must correctly fit the blower and drive shafts so that only light tapping is required to install each half. The two shafts must be accurately aligned, per the coupling manufacturer's requirements, both horizontally and vertically, to limit operating strain on either shaft.

Proper gap between coupling halves must be established according to coupling manufacturers instructions with the motor armature. This will minimize the chance for end thrust on the blower shaft. All direct coupled base mounted units must be re-aligned and greased after field installation. In a v-belt drive, the blower sheave must fit its shaft accurately, run true, and be mounted as close to the bearing housing as possible to minimize bearing loads.

A tight or driving fit will force the drive shaft out of its normal position and cause internal damage. A loose fit will result in shaft damage or breaking. The motor sheave must also fit correctly and be properly aligned with the blower sheave.

Adjust motor position on its sliding base so that belt tension is in accordance with drive manufacturer's instructions. Avoid excessive belt tension at all times. Recheck tension after the first ten hours of operation and periodically thereafter to avoid slippage and loss of blower speed.

Check blower after installation and before applying power by rotating the drive shaft by hand. If it does not rotate freely, look for uneven mountlng, piping strain, excessive belt tension, or coupling misalignment. Check blower at this time to insure oil was added to reservoirs.

SOFT FOOT

Soft foot is a condition in which one of the blower or vacuum booster feet does not sit flat on the base. Usually, this is due to irregularities in the surface to which the blower is mounted. When you tighten the bolt on the foot, the blower will distort slightly, but enough to cause problems with bearing and seal life, and premature internal contact between the rotors and the housing. Figure 3 illustrates the soft foot condition.

1. Place blower on base.
2. Check each foot for gaps between foot and base (soft foot), shim as necessary to fill gap within .002" (.05 mm) The two most common types of soft foot conditions are shown in Figure 3. If either type is present, and measures more than .003" (.076 mm), the blower may fail prematurely.
3. Tighten all bolts.
4. Mount a dial indicator on base contacting one foot at 12 o'clock position.
5. Loosen bolt on that foot. Observe indicator travel and add shims as needed to reduce "spring" to less than .002" (.05 mm).
6. Repeat steps 4 and 5 on remaining feet.

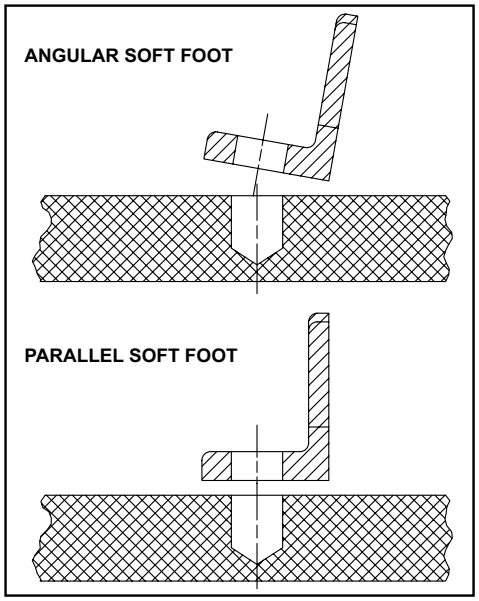


Figure 3 - Illustrations of Soft Foot

ELECTRICAL CONNECTIONS

Wire the motor and other electrical devices such as solenoid valves and temperature switch to the proper voltage and amperage as indicated on the nameplate of each component being wired. Turn the machine by hand after wiring is completed to determine that there are no obstructions and if the booster turns freely; then momentarily start the unit to check the direction of rotation. Figure 2 on page 5 shows direction of air flow in relation to rotor rotation. The air flow direction can be reversed by reversing the appropriate motor leads.

SAFETY

Booster housing and associated piping or accessories may become hot enough to cause major skin burns on contact. Internal and external rotating parts of the booster and driving equipment can produce serious physical injuries. The booster should never be run with the inlet or discharge piping removed. If it becomes necessary to inspect the rotating parts of the booster or to change V-belts, be absolutely sure that all power to the motor controls has been shut off, the motor controls are locked out and properly tagged before proceeding.

Avoid extended exposure in close proximity to machinery with high intensity noise levels. Wear adequate ear protection.

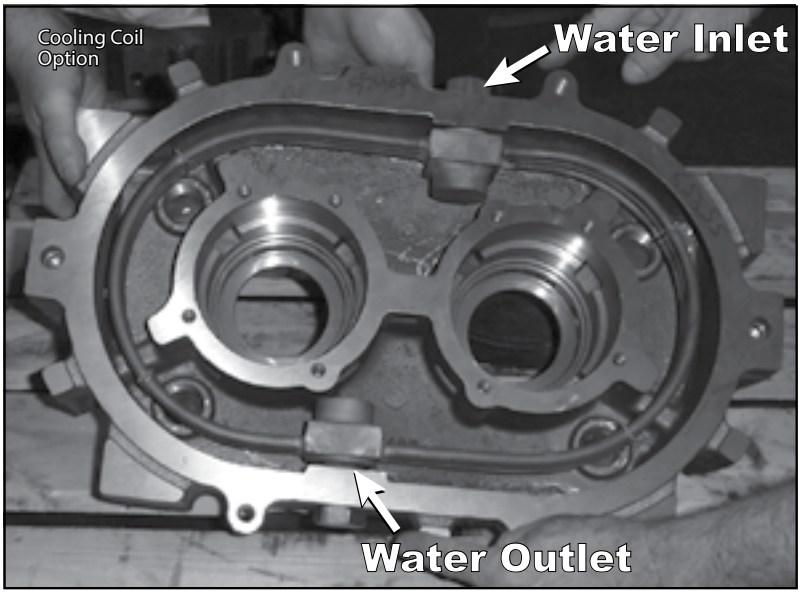
Use proper care and good procedures in handling, lifting, installing, operating, and maintaining the equipment.

PIPING CONNECTIONS

Manifolding should be no smaller than the pump connections in order to minimize restrictions to gas flow. Accurately align the mating flanges to the inlet and discharge manifolding to prevent distortion of the booster housing. If solid particles are likely to be entrained into the air stream, temporarily fit a fine wire mesh filter at the suction port and remove the filter when particles no longer appear. This is especially desirable on new installations and when manifolds have been welded. The manifolding to and from the booster should be fitted with flexible connections to isolate vibrations, absorb expansion and contraction due to thermal change, and to absorb misalignment differences.

COOLING COILS (OPTIONAL)

Shown in photo on the right.



Cooling Coil Option

Cooling coil connections are on the top and bottom of each end plate. The bushing should be fully supported to prevent rotation when installing or removing fittings. During operation, adjust the water flow such that the discharge water temperature is no more than lukewarm (70-80° F [21-27° C])

WARNING: If unit is to be located outside or in a building where ambient temperatures can fall below freezing then care must be taken to ensure the water or liquid used for cooling does not freeze and damage the booster. End plates must be drained of liquid during downtime unless a recirculating unit using a glycol mixture has been installed.

NOTE: Units are never shipped from the manufacturer with liquid in the cooling coils.

COOLING WATER SPECIFICATIONS

Flow rate:	0.5 - 1.0 GPM (1.9 - 3.8 L/min) total for both end plates
Maximum Pressure:	75 PSIG (5.17 bar g)

MOTOR DRIVES

Two drive connections commonly used are direct drive and V-belt drive.

DIRECT COUPLED

When installing the motor directly to the booster, align shafts to coupling in accordance with the coupling manufacturer's instructions. Boosters shipped with motor directly coupled and mounted on a common base have been aligned prior to shipment and normally no further alignment is necessary. However, alignment should be checked and adjustments made if necessary prior to starting the unit.

V-BELTS

If the motor and booster are V-belt connected, the sheaves on both motor and booster shafts, should be as close to the shaft bearings as possible. Blower Sheave is not more than 1/4" (6.5 mm) from the blower drive end cover. The drive sheave is as close to the driver bearing as possible. Care should be taken when installing sheaves on the blower and motor shafts. The face of the sheave should be accurately in line to minimize belt wear.

Adjust the belt tension to the manufacturer's specifications using a belt tension tester. New belts should be checked for proper tension after 24 hours of run time. When manufacturer data is not available industry guidelines are 1/64 inch deflection for each inch of span at 8 to 10 pounds of force in the center of the belt.

Insufficient tensioning is often indicated by slipping (squealing) at start up. Belt dressing should not be used on V-belts. Sheaves and V-belts should remain free of oil and grease. Tension should be removed from belts if the drive is to be inactive for an extended period of time. For more specific information consult the drive manufacturer. In a V-belt drive, the blower sheave must fit its shaft accurately, run true, and be mounted as close to the bearing housing as possible to minimize bearing loads.

A tight or driving fit will force the drive shaft out of its normal position and cause internal damage. A loose fit will result in shaft damage or breaking. The motor sheave must also fit correctly and be properly aligned with the blower sheave.

Adjust motor position on its sliding base so that belt tension is in accordance with drive manufacturer's instructions. Avoid excessive belt tension at all times. Re-check tension after the first ten hours of operation and periodically thereafter to avoid slippage and loss of blower speed.

Check blower after installation and before applying power by rotating the drive shaft by hand. If it does not rotate freely, look for uneven mounting, piping strain, excessive belt tension, or coupling misalignment. Check blower at this time to insure oil was added to reservoirs.

OPERATION

Before starting the booster for the first time under power, recheck the installation thoroughly to reduce the likelihood of troubles. Use the following check list as a guide, but also consider any other special conditions in your installation.

1. Be certain no bolts, rags, or dirt have been left in blower.
2. Be certain that inlet piping is free of debris. If an open outdoor air intake is used, be sure the opening is clean and protected by an inlet filter. This also applies to indoor use.
3. If installation is not recent, check blower leveling, drive alignment, belt tension, and tightness of all mounting bolts.
4. Be certain the proper volume of oil is in the oil reservoir chambers.
5. Be certain the driving motor is properly lubricated, and that it is connected through suitable electrical overload devices.
6. With electrical power off and locked out to prevent accidental starting, rotate blower shaft several times by hand to make sure blower is rotating freely. Unevenness or tight spots is an indication of a problem that should be corrected before progressing.
7. Check motor rotation by momentarily pushing the start button and check flow direction of the blower. Reverse the motor connections if flow is in the wrong direction.

STARTING

Start the backing pump. When pressure is reduced sufficiently, start the vacuum booster. A pressure switch can be installed to start the booster at a predetermined pressure. If the booster is water cooled, adjust the water flow such that the discharge water temperature is no more than lukewarm (70-80° F [21-27° C])

The upper temperature limits for booster operation are between 350-375° F (175-190° C), measured in the exhaust gas stream with a low-mass thermocouple. Operation in deep vacuum requires instrumentation much more sensitive than standard thermometers and mercury type pressure or vacuum gauges. At operation pressures less than 100 Torr (mmHg), low-deadband cut-in switches and low-mass thermocouples should be utilized and positioned such that the sensor is connected to the inlet and discharge connections of the vacuum booster. NPT connections are provided at each of the inlet and discharge ports for this purpose. Standard temperature switches, because of their higher mass, do not have reaction times fast enough to adequately protect the vacuum booster. Likewise, standard vacuum switches are not recommended for cut-in switches as vacuum boosting typically requires a very accurate cut-in point. A tachometer will enable periodic checks of operating speed.

STOPPING

CAUTION: Venting the booster to pressures higher than the cut-in pressure while it is running can damage it. Stop the booster by turning off its drive motor. Isolate the booster from the vacuum system and vent the booster to atmosphere. If water cooling is utilized, shut off the water to the booster. Stop the backing pump. Refer to component instruction manual.

WATER INJECTED VACUUM BOOSTERS

Water injected into the inlet of a blower operating on vacuum service will cool the blower. The water absorbs the heat of compression as it passes through the unit along with the air/gas being compressed. A blower cooled in this manner can operate safely at higher vacuums or higher inlet temperatures than a normally uncooled unit. The amount of water required depends on the inlet air/gas temperature, inlet vacuum, water temperature, and the maximum discharge temperature desired. Check with factory or sales representative for additional guidance.

1. Vertical flow units should always be used with suction at top and discharge at bottom. If your blower or vacuum booster is not in this configuration, consult factory before proceeding.
2. Check oil level in sight glass of blower and assure all fittings are tight.
3. Check the water injection system to assure water is available.
4. Operate the blower dry for a few minutes at no load to check correct rotation and smooth operation.

5. Turn water on and adjust flow as recommended for the individual blower. Assure water discharges freely from the outlet piping.
6. Apply vacuum and observe operation at the desired inlet condition.

CAUTION: Water injection into vacuum boosters with inlet vacuum of 28" Hg (950 mbar g) or deeper, regardless of inlet temperature must be performed carefully to prevent reducing inlet temperature to temperatures below freezing. Operation of boosters with water injection below the freezing point will damage the booster.

CAUTION: Water injection can cause lime or other mineral buildup on rotors. Check water supply for hardness. The use of water softeners, other chemicals, or distilled water may be necessary to prevent or remove this build-up. Tuthill Vacuum & Blower Systems cannot be responsible for damage which may result should this build-up occur. Units should be inspected regularly to determine any problems. For liquid injection other than water, consult the factory.

SHUTDOWN OF WATER INJECTED VACUUM BOOSTERS

1. The booster can be shut down for brief periods by relieving the inlet vacuum, shutting the water off, and then stopping the unit.
2. Rusting during a slightly longer shutdown period can be avoided by operating the booster under a partial vacuum without the water injection, and allowing the booster to heat to within safe limits. The heat will tend to drive off residual moisture.
3. For extended shutdown, oil may be injected into the inlet of the heated blower just prior to shutting the unit down. The oil will provide a protective coating on the internals. Insure that the water is completely shut off after shutdown.
4. Special coatings or platings are available to minimize rusting or corrosion in applications where units can remain wet.

LONG TERM STORAGE

1. Spray the interior (lobes, housing, and end plates) with rust preventative.
2. Apply a rust preventative grease to the drive shaft.
3. Attach a dessiccant bag to either of the covers to prevent condensation from occuring inside the blower. Make sure any dessiccant bag (or bags) is so attached to the covers that they will be removed when dust cover is removed. It is imperative that these be removed before startup of the blower.
4. Store the booster in an air conditioned and heated building if at all possible. At least insure as dry conditions as possible.
5. If possible, rotate the drive shaft by hand at least monthly in order to prevent the seals from setting in one position.

MAINTENANCE & REPLACEMENT PARTS

ITEM	DESCRIPTION	90/91
9	Gear End Bearing	2
10	Free End Bearing	2
12	Rotor Shaft Lip Seal	-
13	Drive Shaft Seal	-
16	Timing Shim	1
24	Key	2
50	Drive Shaft Bearing	1
51	Labyrinth Seal	4
54	Drive Shaft Seal	1
59	Lock Tabs	4
66	Cap Screw	4
68	Spring Pin	4
75	O-Ring	5
91	Nosepiece Lip Seal	1
92	O-Ring	1
199	O-Ring	10

Regular inspection of your blower or vacuum booster and its installation, along with complete checks on operating conditions will pay dividends in added life and usefulness. Particular attention should be paid to lubrication of timing gears and bearings in accordance with comments under Lubrication on page 10. Also, service the drive per manufacturer's instructions and lubricate the coupling or check belt drive tension. By use of thermometers and gauges, make sure that booster operating temperature and pressure remain within allowed limits. When a vacuum booster is taken out of service, it may require internal protection against rusting or corrosion. The need for such protection must be a matter of judgment based on existing conditions as well as length of down time. Under atmospheric conditions producing rapid corrosion, the blower should be protected immediately.

Should adjustments or replacement eventually be needed, these can often be performed locally as described in this book after obtaining required parts. Personnel should have a good background of mechanical experience and be thoroughly familiar with these instructions. Major repairs not covered in this book should be referred to the nearest Tuthill Vacuum & Blower Systems service representative. When ordering parts, give all blower or booster nameplate information, plus the item numbers and names as taken from the appropriate assembly drawing in this book. Numbers shown in parentheses ( ) in the following repair procedures correspond to item numbers in the drawings.

REPAIR PARTS & REPAIR KITS

When ordering repair parts or replacement units, you need to provide:

- Model number and serial number of unit.
- Description of the part. (use the item number shown on the parts list above)

Repair kits are available, consult factory.

SERVICE

Tuthill Vacuum & Blower Systems offers service on all repair parts shipments. If any trouble occurs to a unit within the warranty period, we suggest you immediately contact the factory for assistance. When returning units under warranty, transportation charges must be prepaid to:

Tuthill Vacuum & Blower Systems
4840 West Kearney Street
Springfield, Missouri 65803

LUBRICATION (SPLASH)

Note: Figure 6A and 6B show water connections on the end plate. Each water connection is 1″ NPT. Each end plate is drilled and tapped with (5) water connections. To locate and connect to the proper connections, each water connection has a 1″ NPT plug with a 5/8″ Allen head. Only two (2) plugs in each end plate are to be removed when connecting water to the end plate.

Warning: For connecting water, remove only the 1″ NPT plugs with the 5/8″ Allen heads. Use of any other connection for water will seriously damage to the unit.

Before starting the unit, fill oil reservoirs as instructed below:

1. Remove fill plugs or breathers from gear (drive) end and free (non-drive) end plates.
2. Pour oil through fill hole until oil appears in sight glass. Slowly bring oil up to center of glass. Repeat for both end plates. Each oil sump must be filled independently. See Figure 6A.
3. Re-seal plugs and reinstall in end plates.
4. Oil levels should be checked frequently. Unit must be shut down to properly check oil levels.

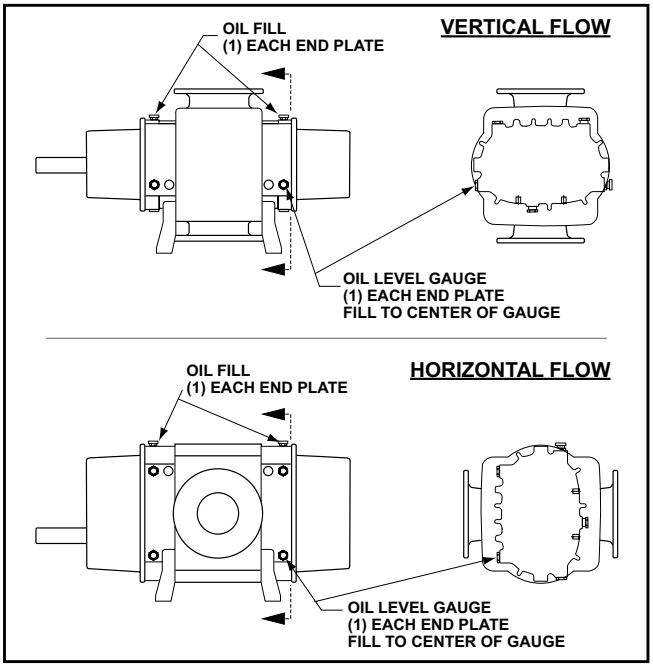


Figure 6A

Warning: Never attempt to change or add oil while the unit is running. Failure to heed this warning could result in damage to the equipment and/or serious personal injury.

Please note the following:

- Time lapse between oil changes will vary depending on operating conditions.
- Higher booster operating temperatures are directly related to higher oil temperatures.
- Boosters utilizing water (liquid) cooling can extend the interval between oil changes considerably. Consult factory if temperature questions arise.
- Every Tuthill Vacuum & Blower Systems blower and vacuum booster is factory tested, oil drained and shipped dry.
- Oil reservoirs must be filled to proper level before operation.
- Lubricants approved for use in Kinney vacuum boosters are shown on page 16.
- Add oil in the quantity shown in the specifications table on page 7.

Warning: Never attempt to change or add oil while unit is running. Failure to heed this warning could result in damage to the equipment and/or serious personal injury.

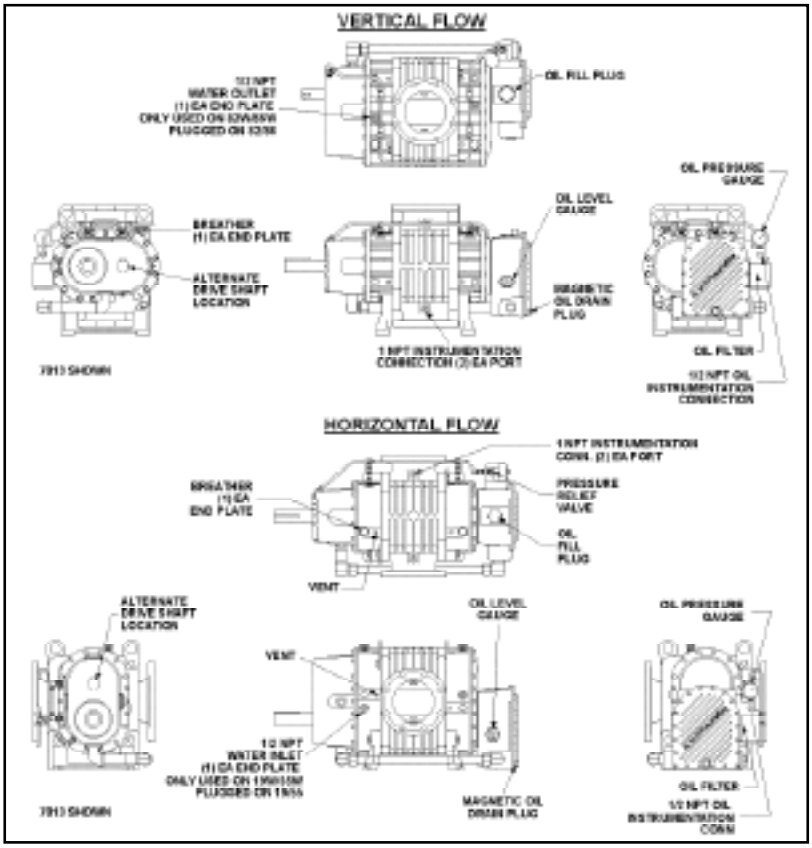


Figure 6B

OIL FILTER

Change the oil filter element with every oil change. Filters (P/N70248) are available from Tuthill Vacuum and Blower Systems in Springfield, Missouri, or from any authorized distributor or service center.

OIL PRESSURE ADJUSTMENT

The oil pressure on your unit has been preset at the factory during the performance test and generally should not require resetting once the unit has been placed in operation. Some adjustment may be required depending on operating speed and oil temperatures. The oil pump itself has no adjustment, however the oil by-pass relief valve located in the oil feed line after the oil filter can be used for the same purpose. See Figure 4.

To make this adjustment, remove the hex cap, loosen the lock nut and turn the set screw clockwise to increase pressure or counterclockwise to lower pressure. Replace cap before taking pressure reading. Oil pressure may vary between 5 PSIG (.34 bar g) and 30 PSIG (2.07 bar g). The unit's oil system can operate satisfactorily at 1 PSIG (.07 bar g), if necessary, and still have sufficient flow. Allow unit to reach normal operating temperature before resetting oil pressure. Set pressure at approximately 15 PSIG (1.03 bar g).

NOTE: Vacuum boosters covered in this manual also include a compound oil pressure/vacuum gauge. This gauge may show vacuum readings due to the evacuation of the end covers, even through positive oil pressure exists. For example: If the booster is operating at 29" Hg (-.98 mbar g) vacuum (assume 29" Hg [-.98 bar g] vacuum in oil chamber) and the pressure gauge is reading 4" Hg (-.14 mbar g) vacuum, the oil pressure is actually at 25" Hg (29-4) or approximately 12 PSI (.84 bar g) positive pressure.

TROUBLESHOOTING

Although Tuthill Vacuum & Blower Systems blowers and vacuum boosters 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 and/or plugs not tightened properly.	Tighten gear housing bolts and plugs.
	Seal failure.	Disassemble and replace seal(s).
	Insufficient sealant.	Remove gear housing and replace sealant.
Excessive bearing or gear wear.	Improper lubrication.	Correct oil level. Replace dirty oil.
	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.
	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.
Excessive operating temperature.	Excessive pressure differential.	Reduce pressure across vacuum booster by lowering cut-in pressure.
		Check blank-off pressure of forepump, and check vacuum system piping and joints for leaks
Rotor end or tip drag.	Insufficient assembled clearances.	Correct clearances.
	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.
	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.

FREQUENTLY ASKED QUESTIONS REGARDING LUBRICATION

What are the perceived modes of failure when units are run beyond the specified duty cycles?

Several things are happening as the lubricant goes through the unit. First, it is absorbing frictional energy in the form of heat. This heat has to be dissipated through either surface contact with cooler materials, or in a rest volume of lubricant. While reducing the friction, the lubricant is also going through a shearing process and the molecular structure is broken down.

The result is that the lubricant will begin to thicken. Because of the shorter molecular chains and the drop out of additive packages. The thickened lubricant will cause more drag, increasing the friction and heat, and further degrading the lubricant.

Operation of the blower (environment, run time, speed, and pressure) has a direct effect on duty cycles. Our published cycles are based on worst-case conditions.

What is the functional detriment if the "wrong oil" is used?

The lubricant is selected based on bearing and gear speed, and operating temperature. Too light of a lubricant increases wear by not separating the sliding surfaces and it will not remove the heat adequately. If the lubricant is too thick, the drag in the bearings is increased causing them to run hotter. Since it is thicker, it will not flow as readily into the gears and it will reduce the available backlash. Lubricants at our conditions are incompressible.

What is the functional detriment if the oil is not serviced?

If the lubricant is not serviced at the proper interval the shearing action in the bearing and the gears will begin to take their toll and the lubricant will thicken, making matters worse. The unit will run hotter and the wear on running surfaces will increase. Generally, the lubricant will appear dirtier, this is actually material rubbed off the unit's components. The discoloration comes from overheating the additive package. An indicator of the breakdown of a lubricant is the increase in the TAN (Total Acid Number), and a change in the base viscosity of ten percent.

DISASSEMBLY

1. Remove unit from installation and drain lubricant from both ends by removing magnetic drain plugs (31). Mark end plates, covers and housing so they can be reassembled in their original position.
2. On 90/91 series boosters only, remove three socket head screws (111) and dust plate (82). Requires 1/8" hex head (Allen) wrench. Using same wrench, loosen three set screws (90) and remove seal retainer (89).
3. Remove four socket head screws (93). Requires 5/32" hex head (Allen) wrench. Place two of the screws in tapped jacking holes and remove seal housing (91). Tap out seal and discard O-rings.
4. Remove gear cover cap screws (26) and gear cover (6) by placing two of the screws in the tapped jacking holes provided on the cover flange. Support cover with lift straps or other suitable means while removing. The jackscrews will provide the force necessary to break the seal between cover and end plate.
5. Temporarily secure end plate to housing with two screws (26) and some flat washers. Remove four nylok screws (66) from drive shaft (45). A light tap with a mallet will break it loose from the drive gear.
6. On 90/91 series boosters only, remove mating ring of mechanical seal (54).
7. Remove inner bearing race with gear puller or press.
8. Bend back lock tabs and remove cap screws (29), lock (59), washers (25), and spring pins (68).
9. Position timing gears (8) so both timing marks are matched. See Figure 7A. Rotate drive gear clockwise approximately three teeth and mark a matching reference line on each gear as shown in Figure 7B. This gear position is necessary so rotors will clear and not jam. Using a gear puller with a live center or a centering adapter, large enough so it will not jam into threaded hole, pull driven gear, while keeping matched reference line marks aligned. Use a slight rocking motion to insure rotors have not jammed. Should jamming occur, release pressure and tap gear back on until it rotates freely. Pull mating gear.
   CAUTION: Never attempt to pull gear when rotors are jammed. Rotor keyway damage will result.
10. Repeat procedure used in No. 4 to remove free end cover (7). Remove rotor shaft screws as was done in No. 6 and also oil slinger (20). Remove cap screws (30) and oil retainer rings (14). Place ½" eye bolt into top of end plate on 91 series, or both sides of end plate on 90 series, in holes provided for lifting.

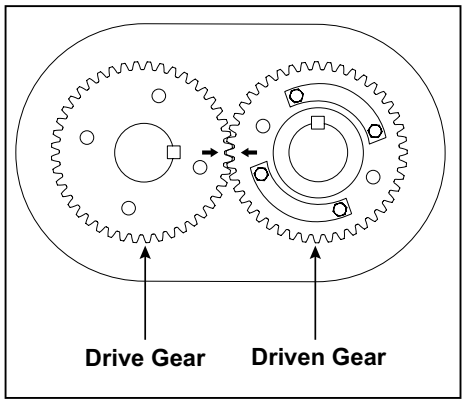


Figure 7A. Timing Marks Matched

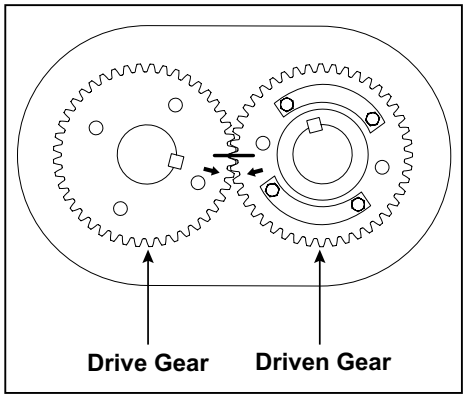


Figure 7B. Timing Marks Advanced 3 Teeth (Reference Marks Aligned)

11. Make up four pieces of threaded rod ½"-13 UNC approximately 9" long with double nuts or a single welded nut to turn rods. On the opposite ends remove about ½" of threads as this end will mushroom slightly when jacking end plate. This will prevent threads from jamming when removing rods. Run in equally to remove end plate. Tap out roller bearings (10). Note that each bearing on this end has two identical spacers (57), one on each side of bearing. Tap out seals (54) or (12). Also remove the labyrinth seals (51), as they should be replaced with each overhaul. On 90/91 series, discard O-ring (75) and retain O-ring spacers (74) for reassembly.
12. Remove cap screws (30) and bearing retainer rings (14) from drive end of unit. Remove rotors (1). To remove the rotors from the end plate will require either a two-jaw gear puller with jaws inserted in the oil feed slots of the bearing bore, or a bar-type puller using the tapped holes around the bearing bore.

    CAUTION: If rotors are side by side, position the lobes vertically when removing. If they are one on top of the other, remove top rotor first in a vertical position. Then position bottom rotor vertically and remove.
13. Support end plate with eyebolts and lift strap. Remove temporary cap screws and tap end plate from housing (3). Remove bearings and seals.
14. Clean and inspect parts for damage and wear. Replace all O-rings, seals, and bearings at each overhaul.

    NOTE: If end plates, housing or end covers are not being reassembled in their original position or some new parts are being used, it will be necessary to clean all paint or rust build-up from the mating surfaces to insure a good seal. Failure to do so could result in excessive end clearances and air or oil leaks.

ASSEMBLY

The assembly procedure is generally the same for all series, but where there are differences, notations are made. Dowel pins are used to locate end plates, housing and end covers in their proper locations relative to each other. Be sure they are in place. An O-ring lubricant should be used on all O-rings.

It is recommended that the gear end rotor shaft bearings be purchased from Tuthill Vacuum & Blower Systems, as they are specially ground to locate the rotors with correct end clearance relative to the gear end plate.

ATTENTION: Make sure all parts are clean and free of any nicks or burrs caused by disassembly. Blowers incorporating lip seals will require all sleeves or seal journals to be polished to remove any nicks and scratches. Failure to polish seal journals will result in seal leakage or damage. Refer to page 17 for seal pressing tools as well as other assembly tools required.

NOTE: When rebuilding the vacuum boosters and depending on the series designation, it may be necessary to reseal the joints between the rotor housing, end plates, and end covers. The following sealers are recommended and are available for purchase from Tuthill Vacuum & Blower Systems.

Dow Corning: RTV 737 General Electric: N-SIL

PREPARATION OF END PLATES FOR ASSEMBLY

1. Press the labyrinth seals (51) into seal bores with the lips toward the oil side. NOTE: For lip seal units put a light coat of silicon in the seal bore of end plate. Install lip seal open side facing up.

MECHANICAL SEAL UNITS

2. Install O-ring spacers (74) with grooves up. Install O-rings (75) making sure they are fully seated in their grooves. Apply a thin coat of sealer to outside dimension of seal (54) and press into seal bore. Make sure seals are fully seated without deforming. Clean seal carbon with soft tissue and cleaning agent (acetone).

GEAR END ASSEMBLY

3. Place free end plate on suitable blocking with rotor side up. Stand rotors (1) into each bore with gear end shafts up and keyways facing in the direction shown in Figure 8.
4. Install the gear end plate (4) over the rotor shafts and coming to rest on top of the rotor lobes, being careful not to damage the seals. Recheck the location of the oil sight glass in relation to the drive rotor before proceeding with the assembly.
5. 90/91 series only: Inspect lapped surface of seal mating ring to be sure it is perfectly clean. Use a soft tissue and cleaning agent if necessary. Place a few drops of lubricating oil on its surface and lubricate the O-ring. Install on rotor shaft with lapped surface down. Slot must line up with pin (300) in rotor shaft. Gently press with fingers to insure compression is taking place and mating ring is not hung up for any reason. Top of mating ring should sit flush with rotor shoulder when fully seated.
6. CAUTION: Gear end bearings have flush ground faces and should be installed with manufacturer numbers up (toward gear). If no numbers appear on either side, look for a black dot (acid mark) on the inner race. Install with dot up (toward gear). Do

not use bearings that have not been flush ground to within .001" (.025 mm) Coat the rotor shafts with an anti-seize lubricant and press the bearings (9) on the shafts. The bearing manufacturer numbers and/or an acid dot (inner race) should be up or toward the gears. Use the tool shown on page 17 along with a length of 3/4-10 x 6" threaded rod, washer (25) and nut. The use of a hydraulic ram with a hollow center is also recommended. In this case the threaded rod will have to be made longer.

7. Install bearing retainer plates (14) and secure with cap screws (30).
8. Check clearance between the face of the end plate and rotor lobes. Refer to clearance table on page 15 for correct gear end clearances. If clearances are not within specifications, recheck parts to find cause of improper clearances before proceeding. Install keys (24) in rotor shaft keyways.
9. Lubricate shafts and keys and press drive gear (right hand helix) on drive rotor. To install driven gear, align reference marks as shown in Fig. 7B on page 12. Tap gear with mallet to start then press the gear until seated. NOTE: All timing gears must be used in sets as they are matched and serially numbered.
10. Install roll pins (68), washers (25), lock tabs (59) and shaft bolts (29). Bend over lock tabs. NOTE: These bolts are structural bolts, not standard cap screws. Therefore they have a larger body diameter and this centers the washers and slinger. Do not replace with standard cap screws.
11. Remove the gear end assembly from the free end plate and turn over so the gears are facing down on a solid surface. Place some wood blocking on each side for support.
12. 90/91 series: Place a small bead of an RTV silicone type sealer around the periphery of the housing (3) bores, but inside the bolt pattern. Encircle the dowel pins. Install rotor housing and temporarily secure to end plate with two cap screws (26) and some flat washers. Check clearances between end of lobes and housing using a flat bar and feeler gauges or a depth micrometer. Refer to exploded view for free end clearances.
13. 90/91 series: Put sealer on rotor housing, same as above. All series: Install free end plate and secure in same manner.
14. 90/91 series: Install seal mating rings as was done in Step 4. All series: Install bearing into endplates.
15. Install oil retainer rings (14) and cap screws (30). Install roll pin (68) washers (25), oil slinger (20) (on drive rotor), lock tabs (59) and bolts (29). Bend over tabs.
16. Install mounting feet (304) with machined surface against housing and secure with lockwashers (80) and cap screws (307). Install lifting lugs (195) with cap screws (196).

ADJUSTING ROTOR INTERLOBE CLEARANCE

17. The driven gear is made of two pieces. The outer gear shell is fastened to the inner hub with four cap screws and located with two dowel pins. A laminated shim, made up of .003" (.076 mm) laminations, separates the hub and the shell. By removing or adding shim laminations, the gear shell is moved axially relative to the inner hub. Being a helical gear, it rotates as it is moved in or out and the driven rotor turns with it, thus changing the clearance between rotor lobes. Changing the shim thickness .014" (.36 mm) will change the rotor lobe clearance .005" (.13 mm).

    EXAMPLE: Referring to Figure 10 , check the clearance at AA (right hand reading) and BB (left hand reading). If AA reading is .017" (.43 mm) and BB reading is .004" (.10 mm), by removing.018" (.46 mm) shims, the readings should then read AA .011" (.28 mm) and BB .010" (.25 mm).

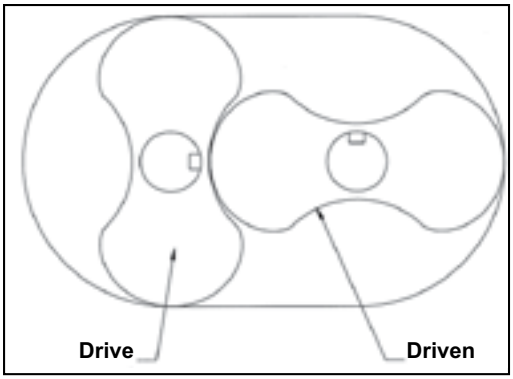


Figure 8.

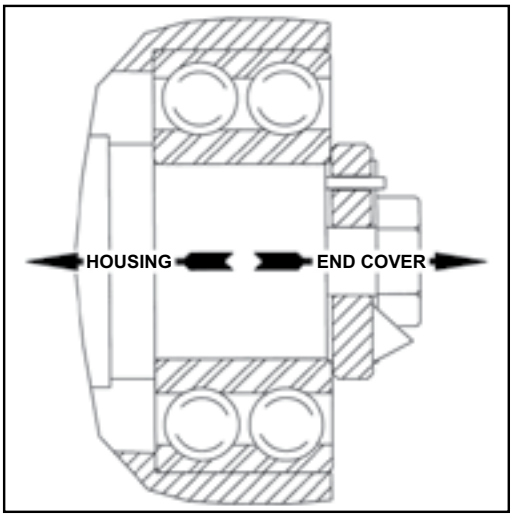


Figure 9.

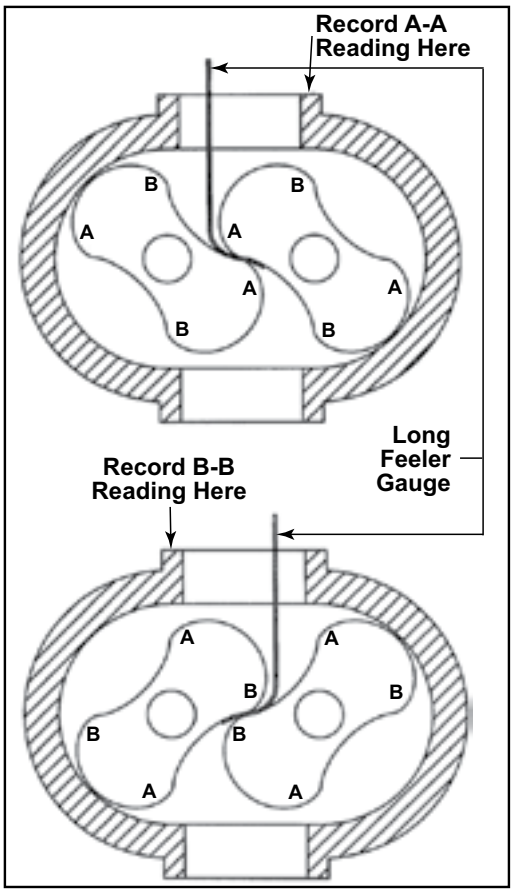


Figure 10.

To determine the amount of shim to add or remove, subtract the smaller reading from the larger and multiply the result by 1.4. (.017" [.43 mm] -.004" [.10 mm] = .013" [.33 mm] x 1.4 = .018" [.46 mm]) If the right side reading is higher than the left side, remove shim. If the right side reading is lower, add shim. The final readings should be within .002" (.05 mm) of each other.

When removing gear shell from driven gear, it is not necessary to remove gear lock bolt. Make sure bolt locks are in place because the dowel pins must come off with the gear shell.

18. Install inner race of drive shaft roller bearing (50) onto drive shaft. Flange side must be inboard. See special tool drawings. Install outer race with rollers into cover bore flush with inside boss. Install oil slingers (395) back to back on drive shaft flange. Make sure both mating surfaces are clean and free of burrs-then mount drive shaft to gear and secure with-Nylok cap screws (29). Check drive shaft runout at seal journal. Do not exceed .003" (.08 mm) T.I.R.
19. Remove temporary cap screws from gear end of housing and place bead of silicone around the periphery of the end plate. Encircle the dowel pins. Install cover (6) and cap screws (26). The use of two ½"-13 threaded rods as guide screws is recommended.
20. Drive shaft seal assembly 90/91 series:

    a. Install O-ring (75) into seal housing (91) and press in stator portion of mechanical seal (54). See special tool drawing. Clean face of carbon and mating ring with soft tissue and acetone. Install O-ring (92).

    b. Lubricate O-ring in ID of mating ring and carefully slide onto drive shaft with slot up and seat against shoulder. Do not use any tools. Lapped surface should be facing outward.

    c. Install seal housing (91) into cover bore and secure with four hex head screws (93).

    d. With set screws (90) in place install mating ring retainer (89) (flange facing outward) while aligning pin (300) with slot in mating ring. Secure to shaft with set screws.
21. Install free end cover (7) same as gear end.

TORQUE CHART

PART	MAX. TORQUE	
	FT.-LBS.	N-m
Rotor 3/4" Structural Bolt	260	350
Bearing Retainer Cap Screw (3/8"-16)	30	40
Nose Piece Flat Head Screw (1/4"-20)	8	10
Dust Slinger Flat Head Screw (10-32)	4	5
1/2" Cap Screw	75	100
3/4" Cap Screw	260	350

CLEARANCES

Metric values are shown in parentheses ( ) — All other values are in inches.

MODEL	GEAR END	FREE END	INTERLOBE	TIP-DOWEL	TIP-PORT
2900	.006-.009 (.15-.23)	.021-.027 (.53-.69)	.010-.014 (.25-.36)	.008-.012 (.20-.30)	.015-.019 (.38-.48)
3600	.006-.009 (.15-.23)	.026-.032 (.66-.81)	.010-.014 (.25-.36)	.008-.012 (.20-.30)	.015-.019 (.38-.48)
4500	.006-.009 (.15-.23)	.031-.037 (.79-.94)	.010-.014 (.25-.36)	.008-.012 (.20-.30)	.015-.019 (.38-.48)

RECOMMENDED LUBRICANTS FOR ROTARY BLOWERS AND VACUUM BOOSTERS

RECOMMENDED LUBRICANTS FOR VACUUM BOOSTERS (90/91 AND 31/33 SERIES)	
REQUIREMENTS	TYPICAL LUBRICANTS
• Suitable for high vacuum service • 68-100 cSt @ 104° F (40° C) • Vapor pressure of 1 micron or less @ 70° F (21° C) • Straight mineral (no additives) or PAO synthetic oil	TUTHILL: KV100 or S500

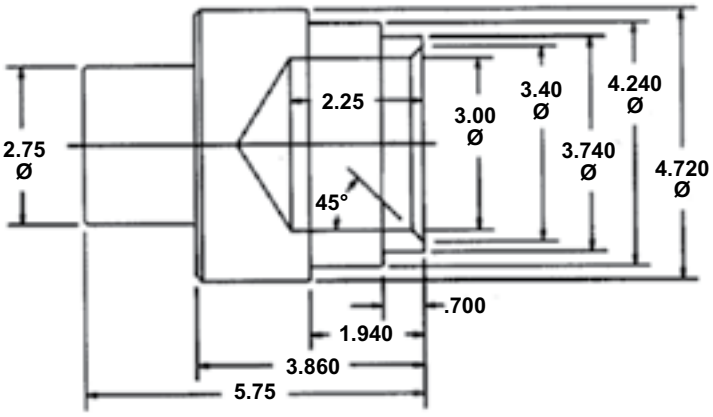
RECOMMENDED MINERAL BASED LUBRICANTS				
AMBIENT TEMPERATURE	SHELL	CITGO	CHEVRON TEXACO	EXXONMOBIL
0° to 32° F (-18° to 0° C)	TELLUS® 68 (ISO 68)	A/W 68 (ISO 68)	RANDO HD 68 (ISO 68)	DTE HEAVY MEDIUM (ISO 68)
32° to 90° F (0° to 32° C)	TELLUS® 100 (ISO 100)	A/W 100 (ISO 100)	RANDO HD 100 (ISO 100)	DTE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

RECOMMENDED SYNTHETIC BASED LUBRICANTS*			
AMBIENT TEMPERATURE	TUTHILL	EXXONMOBIL	SHELL
0° to 32° F (-18° to 0° C)	PneuLube™ (ISO 100)	SHC 626 (ISO 68)	OMALA® RL 68 (ISO 68)
32° to 90° F (0° to 32° C)		SHC 627 (ISO 100)	OMALA® RL 100 (ISO 100)
90° to 120° F (32° to 50° C)		SHC 629 (ISO 150)	OMALA® RL 150 (ISO 150)

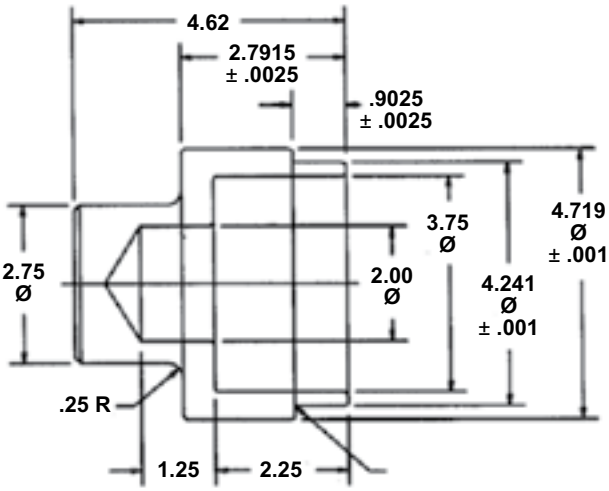
* Blowers used in oxygen-enriched service should use only Castrol Brayco 1726 Plus non-flammable, PFPE synthetic lubricant. Blowers used in hydrogen service should use only PneuLube synthetic oil. Tuthill Vacuum & Blower Systems cannot accept responsibility for damage to seals, O-rings and gaskets caused by use of synthetic lubricants not recommended by Tuthill Vacuum and Blower Systems.

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

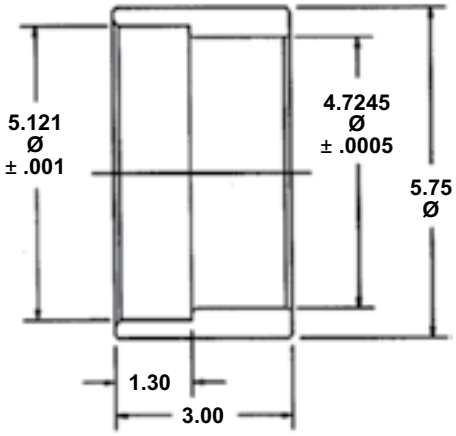
RECOMMENDED SYNTHETIC BASED, FOOD GRADE LUBRICANTS		
AMBIENT TEMPERATURE	Lubricant meeting U. S. FDA regulation 21 CFR 178.3570 governing petroleum products which may have incidental contact with food, and USDA H1 requirements	Lubricant meeting U.S. FDA regulations 21 CFR 172.878 and 178.3620(a) for direct and indirect food contact
0° to 32° F (-18° to 0° C)	PneuLube™ FG (ISO 100)	CONSULT FACTORY
32° to 90° F (0° to 32° C)		
90° to 120° F (32° to 50° C)		



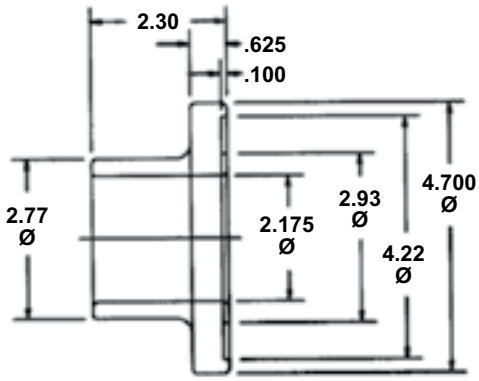
A. LAB SEAL PRESS TOOL



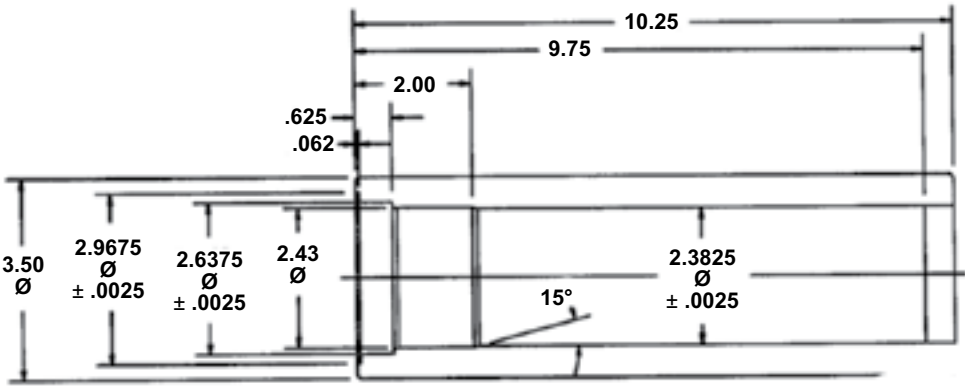
B. MECHANICAL & LIP SEAL TOOL



B1. DRIVE SHAFT MECHANICAL SEAL INSTALLATION TOOL



C. BEARING PRESSING TOOL

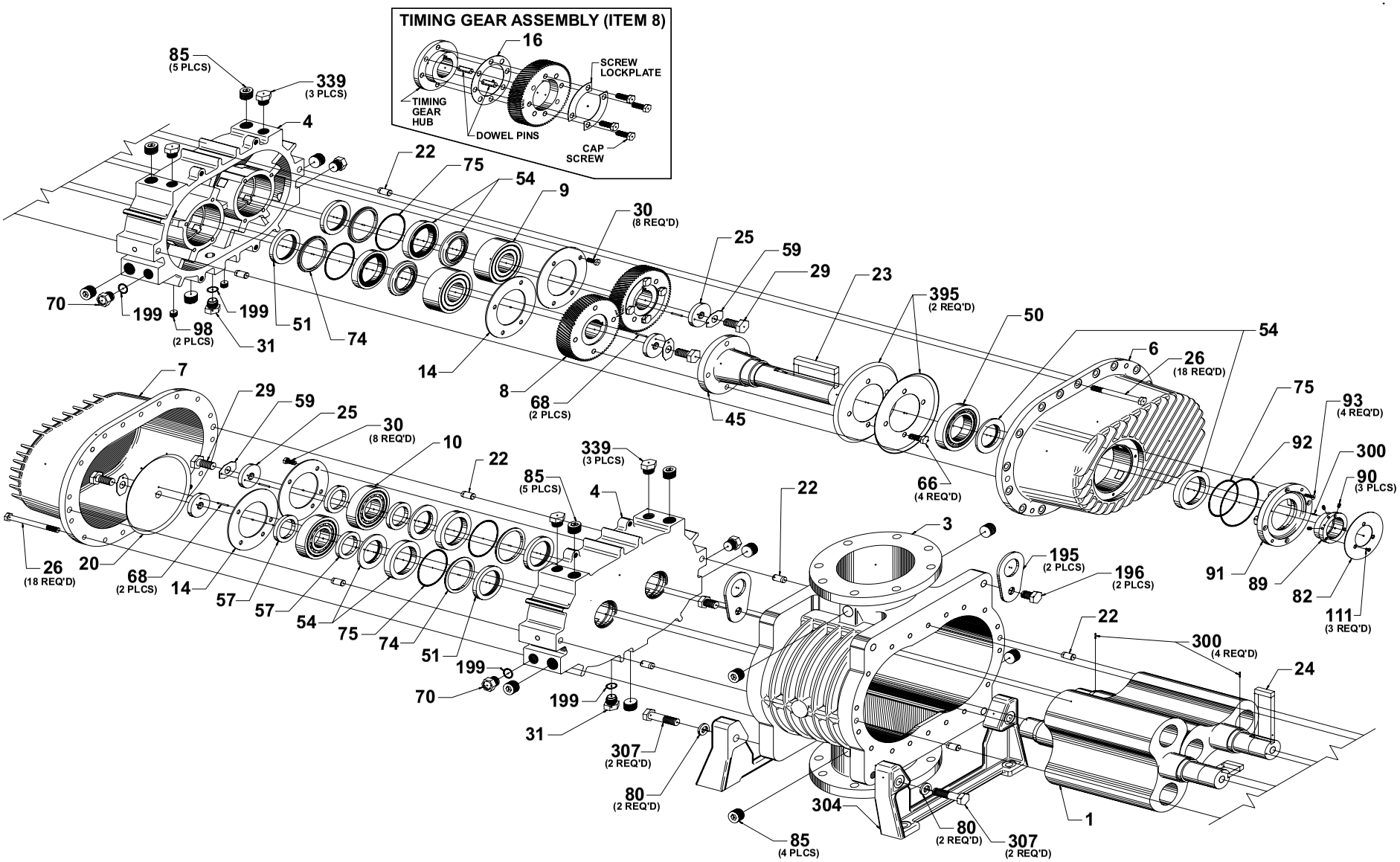


D. DRIVE SFT BRG INNER RACE PRESSING TOOL

TOLERANCES
.XX = ± .01
.XXX = ± .003

BEARING & SEAL PRESSING TOOLS

KMBD 2900, 3600, 4500 VACUUM BOOSTER — EXPLODED VIEW DRAWING



KMBD 2900, 3600, 4500 VACUUM BOOSTER — PARTS LIST

ITEM NO.	PART DESCRIPTION	90/91	31/33
1	ROTOR	2	2
3	HOUSING	1	1
4	END PLATE	2	2
6	DRIVE END COVER	1	1
7	FREE END COVER	1	1
8	TIMING GEAR SET	1	1
9	BEARING	4	
12	LIP SEAL	—	—
13	LIP SEAL (DRIVE SHAFT)	—	—
14	BEARING RETAINER	4	3
15	RETAINING PLATE	—	1
16	TIMING GEAR SHIM	1	1
20	OIL SLINGER	1	1
22	DOWEL PIN	8	8
23	DRIVE SHAFT KEY	1	1
24	GEAR KEY	2	2
25	ROTOR SHAFT WASHER	4	3
26	CAP SCREW	36	36
29	STRUCTURAL BOLT	4	3
30	SOCKET SCREW	16	16
31	MAGNETIC PIPE PLUG	2	1
37	OIL BREATHER	—	—
45	DRIVE SHAFT	1	1
50	BEARING	1	1
51	LABYRINTH SEAL	4	4
54	MECHANICAL SEAL	5	5
59	LOCKING TAB - ROTOR	4	4
66	SCREW	4	4
68	SPRING PIN	4	4
69	CAP SCREW	-	4
70	SIGHT GLASS	4	—
74	SPACER	4	4
75	O-RING	4	5
80	LOCKWASHER - FOOT	4	4
89	MATING RING RETAINER	1	1
90	SET SCREW	3	3
91	SEAL ADAPTER HOUSING	1	1
92	O-RING	1	1
93	SCREW	4	4
100	ADAPTER	—	—
101	STREET ELBOW, 90°	—	1
102	PIPE NIPPLE	—	1
106	PIPE COUPLING	—	1
109	PIPE PLUG	—	14
110	CAP SCREW	—	3
111	FLAT HEAD SOCKET SCREW	3	—
121	PIPE PLUG	—	4
122	SET SCREW	—	2
124	FILTER	—	1
125	MOUNTING BRACKET	—	1
135	TEE	—	4

ITEM NO.	PART DESCRIPTION	90/91	31/33
136	LOCKWASHER	—	4
144	OIL PUMP	—	1
147	TUBE	—	1
155	ELBOW	—	2
161	TUBE	—	2
162	TUBE	—	1
163	ELBOW	—	1
172	REDUCING BUSHING	—	1
174	PIPE PLUG	—	1
178	ADAPTER TUBE	—	2
179	TUBE	—	1
187	TUBE	—	1
188	ELBOW	—	5
195	LIFTING LUGS	—	2
196	CAP SCREW	2	2
199	O-RING	4	—
212	CAP SCREW	—	2
226	WASHER	—	2
235	MALE TUBE ADAPTER	—	5
236	TUBE	—	2
262	PRESSURE GAUGE	—	1
265	VALVE	—	1
270	FILTER ADAPTER	—	1
271	PIPE PLUG	—	2
294	MALE TUBE ADAPTER	—	2
300	SPRING PIN	5	5
302	O-RING	—	2
304	FOOT	2	2
306	SLEEVE	—	1
307	CAP SCREW	4	4
322	CAP SCREW	—	4
325	O-RING	—	1
329	PLUG	—	1
336	ORIFICE	—	5
337	KEY	—	2
339	PLUG WITH O-RING	8	8
349	PIPE NIPPLE	—	1
350	CAP SCREW	—	36
351	PIPE NIPPLE	—	4
354	REDUCING BUSHING	—	5
355	TUBE	—	1
360	TUBE	—	1
369	TUBE	—	1
395	SLINGER, DRIVE SHAFT	2	2
446	PUMP COVER	—	1
449	SPROCKET ADAPTER	—	1
450	ROLLER CHAIN	—	1
451	OIL PUMP DRIVE SPROCKET	—	1
452	OIL PUMP DRIVEN SPROCKET	—	1
458	PUMP HOUSING	—	1
459	OIL SIGHT GAUGE	—	1

NOTES:

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 WITHOUT LIQUIDS PRESENT	PROCESS GASES OTHER THAN AIR, OR ANY LIQUID INJECTED APPLICATION
New (Qx™ models only)	30 months from date of shipment, or 24 months after initial startup date, whichever occurs first.	Consult Factory
New (all other models)	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.

May 2008

OPERATING DATA

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

Model No. _____

Serial No. _____

Startup Date _____

Pump RPM _____

Pump Sheave Diameter: _____

Motor Sheave Diameter: _____

Motor RPM _____ HP _____

V-Belt Size: _____ Length: _____

Type of Lubrication: _____

_____

Operating Vacuum _____

Any other special accessories supplied or in use:

_____

_____

NOTES: _____

_____

_____

_____

_____

_____

IMPORTANT

All mechanical vacuum boosters 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://www.tuthill.com/us/en/about/organization/lob/vacuum/product-registration.cfm

IMPORTANT

All KINNEY® vacuum pumps 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

- Vacuum Furnace ☐
- Vacuum Coating ☐
- Pharmaceutical ☐
- Semiconductor/Electronics ☐
- Food/Meat Packing ☐
- Gas/Petrochemical ☐
- Other _____

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 – VACUUM PRODUCTS
TUTHILL VACUUM & BLOWER SYSTEMS
PO BOX 2877
SPRINGFIELD MO 65890-2150