KINNEY®

Kinney®
Mechanical Vacuum Boosters

Manual 2001 Rev B p/n 002001 0000

WARNING: Do Not Operate Before Reading Manual

Mechanical Vacuum Boosters
OPERATOR'S MANUAL

Models

9012	9027
9016	9036
9020	

31/35/90/92 Series - Vertical Flow
33/37/91/93 Series - Horizontal Flow

800.825.6937 | www.kinneyvacuum.com

Original Instructions

Disclaimer Statement:
All information, illustrations and specifications in this manual are based on the latest information available at the time of publishing. The illustrations used in this manual are intended as representative reference views only. Products are under a continuous improvement policy. Thus, information, illustrations and/or specifications to explain and or exemplify a product, service or maintenance improvement may be changed at any time without notice.

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Product information and specifications subject to change.

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1. INTRODUCTION

CONGRATULATIONS on your purchase of a new **Kinney® Mechanical Vacuum Booster**. Please examine the booster for shipping damage, and if any damage is found, report it immediately to the carrier. If the booster 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 booster is stored outdoors be sure to protect it from weather and corrosion.

This manual covers the installation, operation and maintenance of 9000 Series mechanical vacuum boosters. The boosters are manufactured for either a vertical flow or a horizontal flo . Most in-field drive conversions can be readily accomplished by changing the location of a few external parts.

Mechanical Vacuum Boosters 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 booster. 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.

NOTE

Record the blower 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 identificati n on any replacement part orders, or if you require service or application assistance.

1.1 APPLICABLE DOCUMENTATION

The applicable documents associated with this manual are:
- 2006/42/CE – Machinery Directive
- EN 1012-2:1996 - Compressors and vacuum pumps - Safety Requirements - Part 2: Vacuum Pumps

1.2 SCOPE OF MANUAL

The scope of this manual includes the bare shaft mechanical vacuum booster.

2. CONVENTIONS AND DATA PLATE

2.1 GRAPHIC CONVENTIONS IN MANUAL

This manual is the result of a risk assessment according the applicable documents referenced in section 1.1. The following are hazard levels are referenced within this manual:

DANGER

Indicates an immediate hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates that a physical injury or damage to health or property, if not avoided, could occur.

CAUTION

Indicates that a potential hazard may occur which, if not avoided, could result in minor or moderate injury.

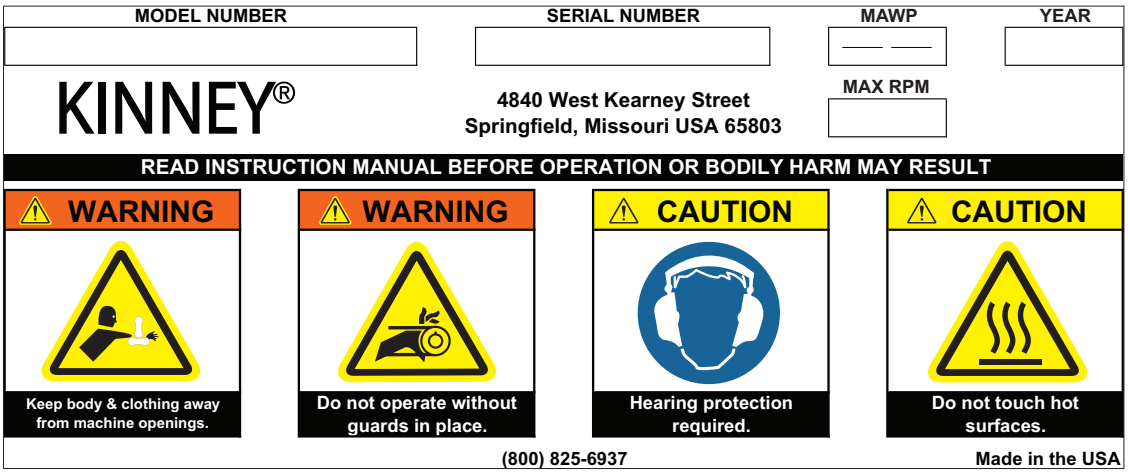
NOTE

Indicates a statement of information which, if not avoided, could cause damage to the product.

CAUTION

Read manual before operation or bodily harm may result. Attention should be given to the safety related sections of this manual.

2.2 DATA PLATE



General Operation and Symbols on Data Plate - The following information is contained on the data plate:

WARNING

Keep body & clothing away from machine.

During operation, keep body and clothing away from inlet and outlet of the booster.

WARNING

Do not operate without guards in place.

CAUTION

Hearing protection is required while the booster is in operation. Noise levels may reach as high as 81 dBA.

CAUTION

Do not touch hot surfaces.

The upper limit of the booster operation is 375° F (190° C). Do not touch the booster while it is in operation and assure booster is cool when not in operation.

MODEL NUMBER: This identifies the specific model of the boost .

SERIAL NUMBER: Each booster has a unique serial number. This number is to be used with any service issues and with any contact with the manufacturer.

YEAR: This states the year that the booster was manufactured.

RPM: This states the maximum RPM that the booster can be operated.

3. LIFTING

WARNING

The booster must be handled using an appropriate device such as a fork truck or appropriate lifting device. See Table 1 for approximate weights. Care should be taken to assure booster does not over-turn during handling and installation.

4. DESCRIPTION

NOTE

Refer to specific data sheets for flow capacities and vacuum capacitie

NOTE

Refer to diagrams in this manual for proper rotation and orientation in inlet and discharge.

Kinney model 9000 mechanical vacuum boosters are positive displacement type units, whose pumping capacity is determined by size, operating speed, and differential pressure conditions. Vacuum boosters employ rotors rotating in opposite directions within a housing 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 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 booster 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 booster, but by the amount of restriction, either downstream of the booster discharge port, or upstream of the booster inlet port.

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 direction of rotation of the booster can make either side the inlet or discharge. See also the *Flow Direction by Rotation* section on page 6.

No attempt should ever be made to control capacity by means of a throttle valve in the intake or discharge piping. This will increase the power load on the drive system, increase operating temperatures, and can overload and/or seriously damage the booster. Likewise, if a possibility exists that flow to the booster inlet may be cut off during normal operation of a process, then an adequate vacuum relief valve must be installed near the booster. A pressure type relief valve in the

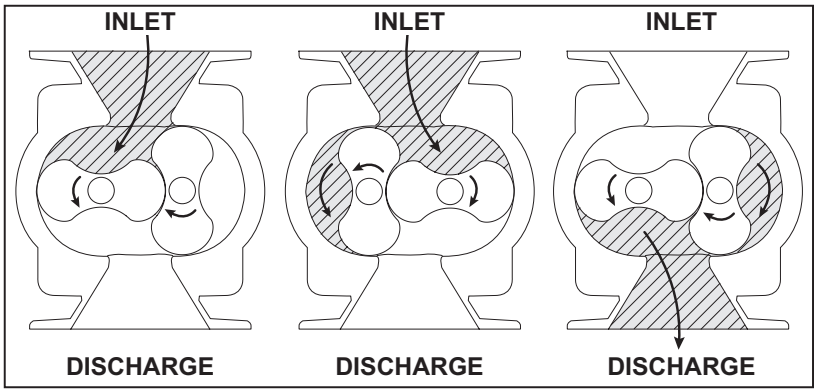


Figure 1 - Illustration of general operation principle

discharge line near the booster is also strongly recommended for protection against cutoff or blocking in this line. Check valves should also be used on every booster when more than one booster is connected to a discharge line. This is for both safety and operating conditions.

Vacuum boosters must be protected by cut-in switches or with bypass valving to limit differential pressure across the booster.

When a belt drive is employed, booster 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. In a direct coupled arrangement, a variable speed motor or transmission is required, or excess air or gas may be blown off through a manually controlled unloading valve and silencer. Gas units can use bypasses, but some applications may require additional cooling. If there is a large volume of high pressure air or gas downstream of the booster, a check valve in the piping downstream of the booster will protect the booster from overspeeding in a backward direction upon shutdown.

Consult your Kinney sales professional if questions arise.

4.1 FLOW DIRECTION BY ROTATION

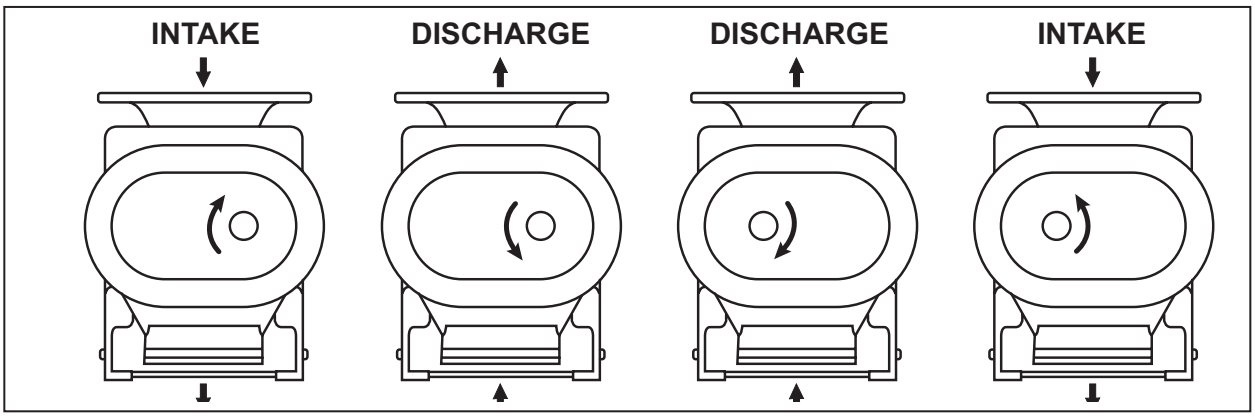


Figure 2 - Flow Direction by Rotation

4.2 SPECIFICATIONS

TABLE 1 — SPECIFICATIONS

MODEL	APPROXIMATE OIL CAPACITY GALLONS / *LITERS*		PORT SIZE IN / *MM*	MAX RPM	APPROXIMATE WEIGHT LBS. / *KG*	
	VERTICAL FLOW	HORIZONTAL FLOW			VERTICAL FLOW 90 / 92 / 92 / 93	HORIZONTAL FLOW 31 / 33 / 33 / 37
9012	7.9 / *30**	4.8 / *18**	10 / *250*	2400	1610 / *730*	1630 / *740*
9016			12 / *300*		1730 / *785*	1750 / *795*
9020			12 / *300*		1980 / *900*	2000 / *910*
9027			14 / *350*		2210 / *1000*	2230 / *1010*
9036			16 / *400*		2510 / *1140*	2530 / *1150*

Maximum discharge temperature is 375°F (190°C). Maximum temperature is based on a 70°F (21°C) inlet temperature. For inlet temperatures below 70°F (21°C), maximum allowable temperature rise across the vacuum booster should also never exceed 305° F (169°C).

* Integral Lube units require up to 2 additional gallons. To permit continued satisfactory performance, a vacuum booster must be operated within certain approved limiting conditions. The manufacturer's warranty is, of course, also contingent on such operation. Maximum limits for pressure, temperature and speed are specified here for various booster sizes when operated under the standard atmospheric conditions. Do not exceed any one of these limits.

EXAMPLE: Seldom does the operation of a vacuum booster result in pressure differentials large enough to strain the booster 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
Specially ordered blowers with nonstandard construction, or with rotor end clearances greater than shown within the *Assembly Clearances* table, will not have the operating limits specified here. Contact your Kinney sales representative for specific information

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
Maximum discharge temperature is 375° F (190° C). Maximum temperature is based on a 70° F (21° C) inlet temperature. For inlet temperatures below 70° F (21° C), maximum allowable temperature rise across the vacuum booster should also never exceed 305° F (169° C).

NOTE
Do not exceed maximum RPM or discharge temperature as stated above

5. INSTALLATION

5.1 GENERAL

DANGER
The booster is not intended to be used with explosive products or in explosive environments.

DANGER
It is the responsibility of the installer to assure that proper guarding is in place and compliant with all applicable regulatory requirements.

WARNING

The bare shaft booster can generate excessive noise. Methods to reduce the noise levels by installing inlet and outlet silencers will be required. Even with inlet and outlet silencers, hearing protection will be required.

WARNING

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

WARNING

Table 1 states the maximum operating speed in RPM (rotations per minute) and maximum temperature. Do not exceed these limits. The installation of the booster shall take these critical operating parameters into account and adequate control features implemented.

WARNING

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 of binding. If booster is removed and still does not move freely, check inside the booster housing for foreign material.

NOTE

Remove the protective covers from the shaft and inspect for damage.

Carefully check to ensure that no transit damage has been sustained. If damage has occurred from shipment a claim must be filed with the carrier immediately; preserve the shipping container for inspection by the carrier.

NOTE

In the event that your unit sustains damage while being shipped to your facility, do not return it to the factory without first obtaining shipping instructions from us.

Protective covers and plugs should not be removed until the connection is being made. Mount the booster on a flat, level surface. We recommend a baseplate that is a rigid, solidly supported, and structurally sound. Shim under the legs where necessary so that each leg of the booster supports an equal share of the booster weight. This is necessary to prevent eventual twisting of the booster. Make sure feet rest evenly on the mounting surface before fastening down. Twisting or cramping the booster in mounting will cause rotor contact and binding during operation, resulting in a condition called “soft foot”. (See the *Soft Foot* section of this manual for further details and preventative measures.)

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. (Also refer to the *Foundation* section.)

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 common motor/booster base or mounting plate, rather than directly under the feet alone.

Piping should be accurately squared with the booster and supported independently. Stress imparted from incorrectly aligned piping or mounting will create problems with bearing and seal life, possibly leading to premature internal contact. The booster should sit stress free and evenly on its supporting surface. Care should be taken to evenly tighten the mounting bolts to not impart undue stress into the booster. Stress can be checked in a free state with feeler stock or verified on a previously installed blower with the aid of a dial indicator. Less than .002" (.05 mm) spring or gap should be found.

A booster may be driven by direct-coupling to the driver or by V-belt drive, to obtain other speeds within approved range. (See the *Motor Drives* section for more information.)

Boosters from Kinney are internally and externally treated after factory assembly and testing to protect against rusting in normal atmospheric conditions prior to installation. The maximum period of internal protection is considered to be up to 6 months under average conditions, provided closing plugs and seals are not removed. Protection against chemical or salt water atmosphere is not provided. Avoid opening the booster until ready to begin installation, as protection will be quickly lost due to evaporation. (For recommended preparations for long term storage (longer than 6 months), please see the *Long Term Storage* section in this manual.)

5.1.1 LOCATION

Install your booster in a room or outdoor area that supplies adequate space and lighting for routine maintenance. Indoor installation areas should be well ventilated and kept as cool as possible, because operating the unit at elevated temperatures can result in nuisance overload or temperature shutdowns. An unprotected outdoor installation is only satisfactory when correct lubrication for expected temperatures is provided, as per the *Recommended Lubricants* section in this manual.

5.1.2 FOUNDATION

Your booster does not need a special foundation, however it does require a solid, level floor and adequate frame support. Bolt the booster to the floor and seal any cracks

5.1.3 BOOSTER AIR INTAKE

To minimize maintenance, supply your booster with the cleanest air possible. It is important that the air does not contain any flammable or toxic gases, as the booster will concentrate these gases. This could result in damage to the unit and surrounding property, lead to personal injury or death. Do not block or restrict the opening or the booster and/or motor may overheat and fail.

Do not use boosters on explosive or hazardous gases. Each size booster has limits on pressure differential, running speed, and discharge temperature. These limits must not be exceeded. Consult Table 1 for details pertaining to the allowable performance criteria.

If it is necessary to take air from a remote source, such as in a vacuum application, the piping should be at least the same diameter of the booster inlet. For distances greater than 20 feet (6 m) the pipe diameter should be enlarged to reduce inlet restriction. Excessive restriction will reduce the efficiency of the booster and elevate its discharge temperature. The piping used should also be corrosion resistant, and free of scale and dirt. The inlet should be covered to keep out precipitation, insects, and small animals. Vacuum kits are available.

5.1.4 SOFT FOOT

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

1. Place booster on base.
2. Check each foot for gaps between foot and base (soft foot), shim as necessary to fill gap within .002" (.05 mm) Below are shown the two most common types of soft foot conditions. If either type is present, and measures more than .003" (.076 mm), the booster 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). Repeat steps 4 and 5 on remaining feet.

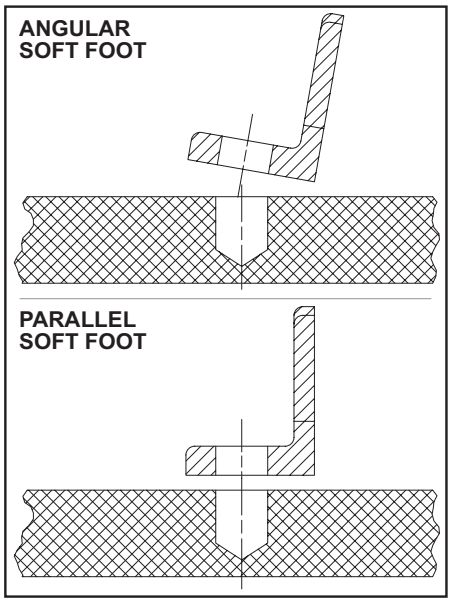


Figure 3 - Illustrations of Soft Foot

5.2 SAFETY

Kinney recommends 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 booster.

DANGER

It is the responsibility of the installer to assure that proper guarding is in place and compliant with all applicable regulatory requirements.

DANGER

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.

DANGER

Assure that properly sized vacuum breaks/relief valves are used on the inlet side of the booster. Also assure that properly sized pressure relief valves are used on the outlet of the booster. The sizing shall be such to assure that the proper flow can be achieved without exceeding the rated vacuum and pressure ratings.

DANGER

Blower housing and associated piping or accessories may become hot enough to cause major skin burns on contact.

WARNING

Use lock out/tag out procedures to disable the electrical energy source before any service or work is done on the booster.

WARNING

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

NOTE

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

5.3 LUBRICATION

Every booster from Kinney is factory tested; oil drained and shipped dry to its installation point. Both oil reservoirs must be filled to the proper level before operation. In addition to the splash lubrication, booster series incorporating pressure lubrication with a integral oil pump, pressure relief valve, filter and oil-to-coolant heat exchanger. Before starting the booster, fill oil sumps as shown below within the *Filling Procedure* section. Kinney approved mineral-based, synthetic and food grade lubricants are listed on page 30.

Select a suitable low vapor pressure lubrication for high vacuum service such as MD full synthetic lubricants. For higher pressure, 1 torr or more, a good grade of turbine lubricating oil may be used. It should have a viscosity of approximately ISO 100 @ 100°F (38°C). Also refer to the Recommended Lubricants page within this manual.

Add vacuum oil to the blower in the quantity shown within the Specifications Table. The oil level must be maintained within the notched area of the sight glass. Lower drive units have “bull’s eye” type oil level gauges. Maintain oil levels at the center of the glass.

WARNING

Never attempt to change or add lubrication while the booster is running. Failure to heed this warning could result in damage to the equipment or personal injury.

WARNING

Properly dispose of the spent lubricants. Refer to the manufacturer of the lubricant and any regulations to assure proper and safe disposal.

WARNING

Do not start the booster until you are sure oil has been put in the gear housing and rear cover. Operation of the booster without proper lubrication will cause the booster to fail and void the warranty.

NOTE

Refer to Table 1 for oil capacities.

5.3.1 FILLING PROCEDURE

See Figure 4. Recommended lubricants are shown on page 32.

1. Remove large hex head fill plug from back (non-drive) end cove .
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 BOTH gear end and drive end sight glasses.
4. Replace and secure fill plug that was removed in step 1

The end cover oil reservoirs are connected together internally by passageways cast into the rotor housing. To change oil, drain from the one-inch square head plug located in bottom of cover, or the on-half inch plug in the oil pump cover.

Oil levels should be checked frequently. Booster must be shut down to properly check oil level.

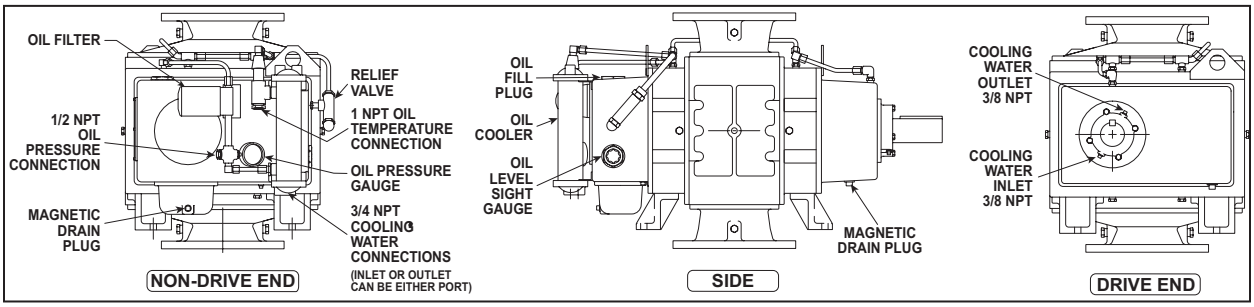


Figure 4 - Location of oil fill, drain plugs, level gauges and cooling connections

5.3.2 FREQUENTLY ASKED QUESTIONS REGARDING LUBRICATION

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.

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

5.3.3 HAZARDS ASSOCIATED WITH BREAKDOWN OR IGNITION OF LUBRICATION

DANGER

There is a risk associated with the lubrication media breaking down and resulting in a hazardous fluid or vapor. There may also be a hazard associated with the ignition of the lubrication media. Refer to the lubrication manufacture's applicable instruction for safety precautions.

5.3.4 LUBRICATION – INTEGRAL PRESSURE (31, 33, 35, 37 series)

5.3.5 OIL FILTER

The oil filter is a self-contained, spin-on type. Change the oil filter element with every oil change. Filters (see table at right) are available from Kinney in Springfield, Missouri, or from any authorized distributor or service center.

OIL FILTERS
SERIES 31/33/35/37

The following oil filters are recommended:

FRAM	PUROLATOR
PH 13	PER 5
PH 20	PER 26
PH 37	PER 40

CAUTION

Factory supplied filters are engineered to provide the proper restriction in the oil lubrication system. Using filters other than those available from Kinney may result in lubrication problems and possibly unwarrantable damage to the booster.

5.3.6 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 required due to the speed and oil temperature. 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.

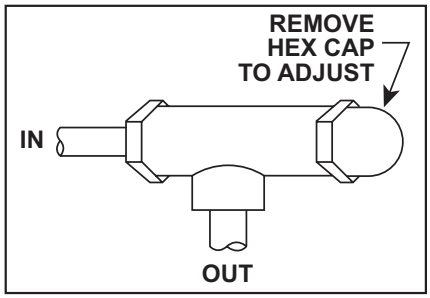


Figure 5 - Pressure Relief Valve

To adjust the unit to the proper oil pressure, remove the hex cap shown in the image to the right. 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. Oil pressure may vary between 5 psig and 30 psig. The unit's oil system can operate satisfactorily at 1 psig, if necessary, and still have sufficient flo . 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).

NOTE

All boosters have a composite (vacuum/pressure) oil gauge. This gauge may show negative pressure or vacuum readings due to the evacuation of the end covers, even though positive oil pressure exists. For example: if the booster is operating at 29 in. Hg vacuum (assume 29 in. Hg vacuum in oil chamber) and the pressure gauge is reading 4 in. Hg vacuum, the oil pressure is actually at 25 in Hg or approximately 12 psi positive pressure.

5.3.7 OIL COOLER

The supply line to the cooler can be connected to either hole. 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. 1.5 to 2 GPM (5 to 7.5 L/min) of 60° F (15° C) water is generally sufficient. Actual water usage will depend on the booster operating condition.

WARNING

If the 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. Oil cooler must be drained of liquid during downtime unless a re-circulating unit using a glycol mixture has been installed.

5.4 PIPING CONNECTIONS

WARNING

Pipe loading on the booster should be negligible as pipe loading can cause distortion of the booster. Use proper supports and pipe hangers to assure that there is no loading.

NOTE

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

Manifolding should be no smaller than the pump connections in order to minimize restrictions to gas flo . Accurately align the mating flanges to the inlet and discharge manifolding to prevent distortion of the booster housing. Temporarily fit a fine wire mesh filter at the suction port if solid particles are likely to be entrained into the air stream 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. If the booster is to be water cooled, connect a clean supply to the ¼" NPT connection on the seal adapter housing adjacent to the drive shaft. The drain line will be connected on the bottom of the non-drive end reservoir, see Figure 4 for connection locations. Care should be taken to not over tighten or loosen the bushing for the cooling coil connection. The bushing should be held in place as additional fitting and plumbing is performed

HAZARDS ASSOCIATED WITH HAZARDOUS PROCESS FLUIDS

DANGER

It shall be the responsibility of the installer to ensure that piping is adequate, sealing between pipe joints is adequate for the process fluids and proper process and pressure protection devices are in place. It is also the responsibility of the installer to assure that process gasses are not vented in a manner that would be hazardous.

Refer to the manufacturer of the process media to assure that proper safety precautions are in place.

5.4.1 BLOCKAGE OR RESTRICTION

WARNING

Damage to the booster could occur if there is blockage in the inlet or outlet ports or piping. Care should be taken when installing the booster to assure that there are no foreign objects or restrictions in the ports or piping.

5.5 MOTOR DRIVES

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

5.5.1 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.

Coupling halves must correctly fit the booster and drive shafts so that only light tapping is required to install each half. The two shafts must be accurately aligned, A direct coupled booster and motor must be aligned with the two shafts not having more than .005" (.13 mm) T.I.R. (Total Indicator Reading). Face must be aligned within .002" (.05 mm) .

Proper gap between coupling halves must be established according to coupling manufacturers instructions with the motor armature. This will minimize the change for end thrust on the booster shaft. All direct coupled base mounted units must be re-aligned and greased after field installation.

5.5.2 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. Booster Sheave is not more than 1/4" (6.5 mm) from the booster drive end cover. The drive sheave is as close to the driver bearing as possible. Care should be taken when installing sheaves on the booster and motor shafts. The face of the should be accurately in line to minimize belt wear.

Adjust the belt tension to the to the manufactures 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 booster 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 booster 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 booster speed.

Check booster 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 booster at this time to insure oil was added to the reservoirs.

SETTING V-BELT TENSION

Proper belt tension is essential to long booster life. The following diagrams and procedures are provided to aid in field adjusting V-belts (when booster is so equipped) for maximum performance. A visual inspection of the V-belt drive should yield the appearance shown in Figure 6.

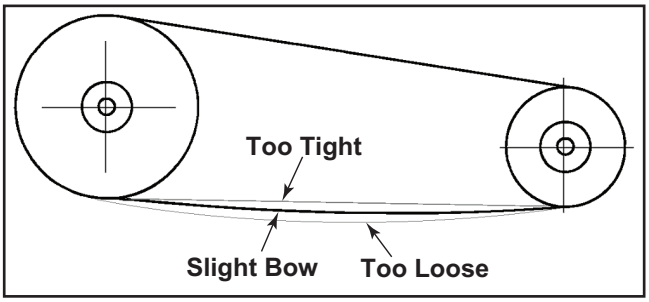


Figure 6 - General appearance of a V-Belt drive

Factors outside the control of the belt tensioning system used on an individual booster package assembly may contribute to decreased belt life, such as environmental factors, and quality of the belts installed. This can cause wear of the belts beyond the ability of the tensioning system to compensate.

As such, it is recommended to check belt tension monthly and make any manual adjustments found necessary.

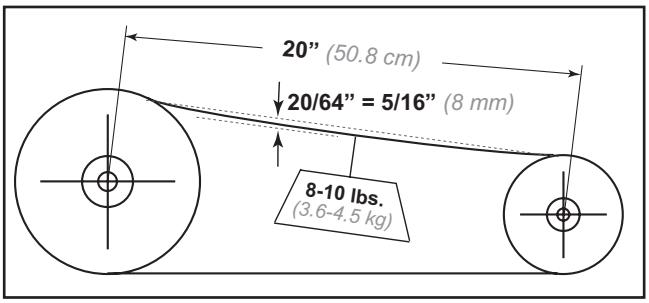


Figure 7 - Setting of proper tension for a V-Belt drive

1. Turn off and lock out power.
2. Remove the fasteners from the belt guard (if equipped)
3. Remove the belt guard.
4. Check and adjust the belt tension as necessary. It should be 1/64" deflection per inch of span (0.157 mm) deflection per centimeter of span) between sheaves, with 8-10 lbs. (3.6-4.5 kg) force applied at center point of the top section of belt.
5. Install the belt guard, making sure that all drive components are free of contact with the guard.
6. Install belt guard fasteners removed in step 2.
7. Unlock the power and start your booster.
8. Resume normal operation.

5.5.3 V-BELT TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSES	SOLUTION
Belts slip (sidewalls glazed)	Not enough tension	Replace belts; apply proper tension
Drive squeals	Shock load	Apply proper tension
	Not enough arc of contact	Increase center distance
	Heavy starting load	Increase belt tension
Belt(s) turned over	Broken cord caused by prying on sheave	Replace set of belts and install correctly
	Overloaded drive	Redesign drive
	Impulse loads	Apply proper tension
	Misalignment of sheave and shaft	Realign drive
	Worn sheave grooves	Replace sheaves
	Excessive belt vibration	Check drive design Check equipment for solid mounting Consider use of banded belts
Mismatched belts	New belts installed with old belts	Replace belts in matched sets only
Breakage of belt(s)	Shock loads	Apply proper tension; recheck drive
	Heavy starting loads	Apply proper tension; recheck drive Use compensator starting
	Belt pried over sheaves	Replace set of belts correctly
	Foreign objects in drives	Provide drive guard
Rapid belt wear	Sheave grooves worn	Replace sheaves
	Sheave diameter too small	Redesign drive
	Mismatched belts	Replace with matched belts
	Drive overloaded	Redesign drive
	Belt slips	Increase tension
	Sheaves misaligned	Align sheaves
	Oil or heat condition	Eliminate oil. Ventilate drive.

5.6 MOTOR AND ELECTRICAL CONNECTIONS

WARNING

The motor and connections shall be protected to assure that product and environmental condensation does not come in contact with the electrical connections.

NOTE

It is the responsibility of the installer to assure that the motor is in compliance with the latest edition of IEC 60204-1 and all electrical connections performed per IEC 60204-1, this includes over current protection.

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 booster by hand after wiring is completed to determine that there are no obstructions and if the booster turns freely; then momentarily start the booster to check the direction of rotation. Figure 2 shows direction of air flow in relation to rotor rotation. The air flow direction can be reversed by reversing the appropriate motor leads

6. OPERATION

6.1 GENERAL

DANGER

The booster is not intended to be used with explosive products or in explosive environments.

WARNING

Do not operate without guards in place.

WARNING

Maximum operating speed: Table 1 states the maximum operating speed in RPM (rotations per minute) and maximum temperature. Do not exceed these limits.

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 booster.
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 filte . This also applies to indoor use.
3. If installation is not recent, check booster 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 booster shaft several times by hand to make sure booster 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 booster. Reverse the motor connections if flow is in the wrong direction

Initial operation should be carried out under “no load” conditions by opening all valves and venting the discharge to atmosphere, if possible. Then start motor briefl , listen for unusual noises, and check that the booster coasts freely to a stop. If no problem appears, repeat this check, and let the motor run a little longer. If any questions exist, investigate before proceeding further.

Assuming all tests are satisfactory, the booster will now be ready for continuous full load operation. During the first several days, make periodic checks to determine that all conditions remain acceptable and steady. These checks may be particularly important if the booster is part of a process system where conditions may vary. At the first opportunity, stop the booster and clean or remove inlet filte . Also, recheck leveling, coupling alignment or belt tension, and mountlng bolts for tightness.

6.2 START-UP CHECKLIST

We recommend that these startup procedures be followed in sequence and checked 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 booster has been moved to a new location

DATES CHECKED:				

☐☐☐☐ Check the unit for proper lubrication. Proper oil level cannot be over-emphasized. Refer to the *Lubrication* section. Please see *Recommended Lubricants* for information on acceptable lubricants for your product.

☐☐☐☐ Check V-belt drive for proper belt alignment and tension.

☐☐☐☐ Carefully 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 booster, motor, or drive components.

☐☐☐☐ "Bump" the unit with the motor to check rotation (counter-clockwise [CCW] when facing shaft) and to be certain it turns freely and smoothly.

☐☐☐☐ 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* chart.

☐☐☐☐ Apply the load and observe the operation of the unit for one hour.

☐☐☐☐ If minor malfunctions occur, discontinue operation and refer to the *Troubleshooting* chart.

6.3 STARTING

Check the oil for proper level at both ends of the booster. Add or drain oil as necessary to bring the oil to the correct level. See Figure 4. Too much oil, particularly on the gear end, can result in excessive heat generation. Too little oil will possibly result in failure of the timing gears, bearings, and mechanical seals.

Start the backing pump. When pressure is reduced sufficientl , start booster pump. A pressure switch can be installed to start the booster at a predetermined pressure. If the booster is water cooled turn on the cooling water when the booster is started. Adjust the water flow so that the discharge water temperature is no more than lukewarm (70° to 80° F [21° to 26° C]).

6.4 OPERATING

The upper temperature limit for booster pump operation is 375° F (190° C) measured in the exhaust gas stream with a low mass thermocouple. When this temperature limit switch is installed, as the temperature exceeds the predetermined temperature, the booster motor will stop and cannot be restarted until the temperature drops below the trip setting of the temperature switch.

DANGER

The booster is not intended to be used with explosive products or in explosive environments.

WARNING

Physical harm may occur if human body parts are in contact or exposed to the process vacuum. Assure that all connections are protected from human contact.

WARNING

If rated vacuum or pressure levels are exceeded, process fluids will migrate to other parts of the booster and system.

CAUTION

Do not touch hot surfaces.

The upper limit of the booster operation is 375° F (190° C). Do not touch the booster while it is in operation and assure booster is cool when not in operation.

CAUTION

Use of a thermowell insulates the thermocouple. Invalid and delayed readings will result. This can result in ineffective protection devices.

NOTE

The upper limits are not intended for continuous operation. Consult with factory for detailed information assistance.

6.5 STOPPING

CAUTION

Venting the booster to pressures above cut-in while running can damage the pump.

Stop the booster by turning off the motor. Isolate the booster from the vacuum system and vent the booster to atmosphere. Turn off the cooling water if water cooled. Stop the backing pump. Refer to component instruction manual.

6.6 WATER INJECTED VACUUM BOOSTERS

Water injected into the inlet of a booster operating on vacuum service will cool the booster. The water absorbs the heat of compression as it passes through the unit along with the air/gas being compressed. A booster 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 the factory or sales representative for additional guidance.

6.6.1 OPERATION

1. Check oil level in sight glass of booster and assure all fittings are tight
2. Check the water injection system to assure water is available.
3. Operate the booster dry for a few minutes at no load to check correct rotation and smooth operation.
4. Turn water on and adjust flow as recommended for the individual booster. Assure water discharges freely from the outlet piping.
5. Apply vacuum and observe operation at the desired inlet condition.

6.6.2 SHUTDOWN

1. The booster can be shutdown 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, allowing the booster to heat 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 booster just prior to shutting the booster 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.

Vertical flow units with two-lobed, plugged rotors should always be used. Always orient system such that the booster intake is at the top and discharge at the bottom.

CAUTION

Water injection can cause lime build-up 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. However, due to the wide variations in mineral content, pH, and chemical content of water that can be injected, Kinney cannot be responsible for damage which may result should this build-up occur. Units should be inspected regularly to determine any problems.

NOTE

For liquid injection other than water, consult the factory.

6.7 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 booster is shut down and the booster 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 booster to fail upon future start-up.

The following shutdown procedure outlined below minimizes the risk of moisture condensation, corrosion and freezing.

NOTE

Care must be taken so as not to overload or overheat the booster during this procedure.

1. Isolate the booster from the moist system piping, allowing the booster to intake atmospheric air. Operate the booster under a slight load allowing the booster to heat within safe limits. The heat generated by the booster will quickly evaporate residual moisture.
2. For carpet cleaning applications, after the work is completed, simply allow the booster 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 booster 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 booster just prior to shutdown. *(3-in-One and WD-40 are registered trademarks of WD-40 Company.)* 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 booster. The applicator tube will damage the booster, most likely to the point that repair would be required.
4. If the booster is being taken out of commission for an extended period of time, please also refer to the *"Long Term Storage"* section of this manual.

7. MAINTENANCE

7.1 GENERAL

Regular inspection of your vacuum booster and its installation, along with complete checks on operating conditions will pay dividends in added life and usefulness. 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.

DANGER

The booster and parts may contain hazardous media. Assure that pump and parts are evacuated of hazardous media prior to servicing.

CAUTION

The electrical service must be isolated and de-energized prior to maintenance. Apply appropriate procedures to assure electrical supply is de-energized and cannot be inadvertently energized during maintenance.

Assure piping and product is isolated prior to maintenance of booster. Apply appropriate procedures to assure piping and product is isolated and that inadvertent opening of valves cannot occur during maintenance.

CAUTION

During routine maintenance, inspect and assure that guards are in place and secure.

NOTE

When changing oil be sure to reseal the drain and fill plugs. This is especially important on 35/3792/93 series which have no mechanical seals on the rotors. Air leaks past these plugs can cause rapid loss of oil from end covers resulting in booster failure.

Particular attention should be paid to lubrication of timing gears and bearings in accordance with comments under the *Lubrication* section.

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 booster should be protected immediately. Refer to the *Long Term Storage* section for more details.

7.2 REGULAR MAINTENANCE

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

A newly installed booster should be checked frequently during the first month of operation, especially lubrication. With booster at rest, check oil level in both the gear (drive) end and free (non-drive) end of the booster and add oil as needed. Scheduled maintenance consists of changing lubricating oil every 250 to 1500 hours of operation, or more frequently depending on the type of oil and operating temperature. Boosters with mechanical seals on the rotors can generally run the full 1500 hours before an oil change is required. Also change the oil more frequently if pumping corrosive vapors or where excessive operating temperatures are encountered. The following is recommended as a minimum maintenance program.

DAILY	WEEKLY	MONTHLY
1. Check and maintain oil level, and add oil as necessary. 2. Check for unusual noise or vibration (See *Troubleshooting*)	1. Clean all air filters. A clogged air filter can seriously affect the efficiency of the booster and cause overheating and oil usage. 2. Check relief valve to assure it is operating properly.	1. Inspect the entire system for leaks. 2. Inspect condition of oil and change if necessary. 3. Check drive belt tension and tighten if necessary.

NOTE
Oil levels should be checked every 24 hours of operation.

Proper oil drain schedules require oil be changed before the contaminant load becomes so great that the lubricating function of the oil is impaired or heavy disposition of suspended contaminants occurs. To check the condition of the oil, drain a sampling into a clean container and check for the presence of water or solids. Slight discoloration of the oil should not necessitate an oil change.

7.3 SPARE PARTS

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 the procedures outlined in this manual. Major repairs not covered in this book should be referred to the nearest Kinney service representative.

When ordering parts, give all booster nameplate information, as well as the item number and parts description as per the parts lists and assembly drawings for your particular model. Repair kits are available for all models. These kits contain all of the seals, bearings, O-rings, locks, and special retaining screws necessary for an overhaul. For your convenience when ordering parts, we suggest you complete the *Operating Data Form* included on the inside, back cover of this manual.

In developing a stock of spare parts, consider the following:

- The degree of importance in maintaining the booster in a “ready” condition
- The time lag in parts procurement
- Cost
- Shelf life (seals and O-rings)

Contact Kinney Service Department for any assistance in selecting spare parts.
Telephone: (417) 865-8715 — Toll Free (48 contiguous states): (800) 825-6937 — Fax: (417) 865-2950

7.4 FACTORY SERVICE & REPAIR

With proper care, Kinney vacuum boosters will give years of reliable service. The parts are machined to very close tolerances and require special tools by mechanics who are skilled at this work. Should major repairs become necessary, contact the factory for the authorized service location nearest you. Units which are still under warranty must be returned to the factory, freight prepaid, for service.

Kinney
ATTN: Customer Service Manager
4840 West Kearney Street
Springfield, MO 65803-870

NOTE

Current regulations require Material Safety Data Sheet to be completed and forwarded to Kinney on any unit being returned for any reason which has been handling or involved with hazardous gases or materials. This is for the protection of the employees of Kinney who are required to perform service on this equipment. Failure to do so will result in service delays.

NOTE

When returning a booster to the factory for repair, under warranty, please note the factory will not accept any unit that arrives without authorization. Contact the Service Department for return authorization.

NOTE

Most of the cap screws used on the model 9000 have metric threads, which can be identified by the numbers that appear on the screw head – EXAMPLE: 8.8M. The use of other than metric cap screws will result in hole thread damage. Series 31/33/35/37 have a few cap screws with SAE threads, all of which are located on the lube oil pump and related parts.

NOTE

When rebuilding the model 9000, it will be necessary to reseal the joints between the rotor housing, end plates and end covers and port fittings. The following sealers are recommended and available for purchase from Kinney: **Loctite Corporation — Loctite 515**

7.5 LONG TERM STORAGE

Any time the booster will be stored for an extended period of time, you should take make sure that it is protected from corrosion by following these steps:

1. Spray the interior (lobes, housing and end plates) with rust preventative. This should be repeated as conditions dictate and at least on a yearly basis.
2. Fill both end covers completely full of oil.
3. Firmly attach a very prominent tag stating that the end covers are full of oil and must be drained and refilled to proper levels prior to startup
4. Apply a rust preventative grease to the drive shaft.
5. Spray all exposed surfaces, including the inlet and discharge flanges, with rust preventative
6. Seal inlet, discharge and vent openings. It is not recommended that the unit be set in place, piped to the system, and allowed to remain idle for a prolonged amount of time. If any component is left open to the atmosphere, the rust preventative will escape and lose its effectiveness.
7. During storage, ensure that the booster does not experience excessive vibration.
8. Attach a desiccant bag to either of the covers to prevent condensation from occurring inside the booster. Make sure any desiccant bag (or bags) is so attached to the covers that they will be removed before startup of the booster.
9. Store the booster in an air conditioned and heated building if at all possible. At least insure as dry conditions as possible.
10. If possible, rotate the drive shaft by hand at least monthly in order to prevent seals from setting in one position.

8. DISASSEMBLY AND ASSEMBLY

8.1 DISASSEMBLY

1. Drain lubricant from free end cover (7) by removing magnetic drain plug (31) or (1 08). Disconnect or remove the external oil lines, oil filte , and heat exchanger if applicable. Port fittings (38) may also be removed. Mark all parts so they can go back in their original position when reassembling.

8.1.1 FREE END DISASSEMBLY

2. **Series 90/91/92/93** - Proceed to step 3.
   Series 31/33/35/37 - In order to remove the free end cover (7) the submerged oil pump assembly must first be disconnected and removed. See complete Drive Assembly Instructions.
   a. Remove cap screws (350), pump cover (446), and cover plates (323 & 303). Discard O-rings (325).
   b. Disconnect hose (150) at swivel adapter (340) or (330).
   c. Locate and remove master link (450B) on drive chain (450A) then remove chain.

NOTE
If the booster is bound up and cannot be rotated, and the master link cannot be reached, remove screws (309) and slide out the adjusting shims (53). You should now have enough slack to loosen setscrews and remove upper sprocket along with the chain.

   d. Remove the three cap screws (309) and oil pump assembly from bottom of cover. Remove cap screws (321) and pull bearing carrier (447) and bearing (362). No further disassembly is required unless oil pump is to be replaced.
   e. To replace oil pump continue disassembly by loosening two set screws (122), sliding off sprocket (452) and sleeve (306). Remove oil pump (144) from bracket (125).
3. Support free end cover (7) with lifting sling and remove cap screws (26). Cover flange has two tapped holes for jackscrews to assist in removal.
4. **Series 31/33/35/37** - Loosen set screws and remove sprocket (451). Remove cap screws (69), oil slinger (20) and adapter (449).
   Series 90/91/92/93 - Remove cap screws (69), oil slinger (20), and spacer (197).
5. Remove retainer rings (220) from ends of rotor shafts. Remove cap screws (62) and oil retaining rings (15).

8.1.2 GEAR END DISASSEMBLY

6. Remove cap screws (93) and water cooling housing (278). Discard O-rings (140 & 279). Remove cap screws (62). Use two as jack screws and remove seal housing (91). Tap out seal (76B) and discard O-ring (92). Remove retaining ring (78) and mating ring portion of seal (76A).
7. The gear end cover (6) also has jack screw holes but it must slide off a spherical roller bearing and two dowel pins. Use appropriate length screws and a support sling. See Figure 15 for a bearing alignment tool that can be helpful in cover removal.
8. Remove retainer ring (47) and pull bearing (50).
9. Remove cap screws (66) and drive shaft (45). Jackscrew holes have been provided.
10. Remove cap screws (29) and rotor shaft washers (25). On top drive units only, a slinger (395) sandwiched between two washers (25) is used on the lower rotor. Note position before removal.
11. Remove the timing gears (8). Either gear may be used as the drive gear. Normally the solid gear (right hand helix) will be the drive gear. The two piece gear (gear shell and hub) will be the driven gear. Align the match marks and remove the cap screws in the two piece gear. Using a suitable puller, remove the gear shell from its hub. Never use excessive force to remove. A slight rocking motion while pulling the gear will ensure that jamming has not occurred. If jamming does occur, tap gear back on until free moving and recheck location of timing marks. Using same puller, remove the gear hub and solid gear.
12. Remove cap screws (62) and retainer rings (14).

8.1.3 END PLATE AND ROTOR DISASSEMBLY

13. Stand blower on its free end on 4 x 4 blocks and remove mounting feet (304).
14. Remove end plate cap screws (26). The end plate, with the bearings must be pulled from the rotor shafts. Use two fixtures as shown in Figure 14. Secure each fixture to the bearing retainer bolt holes and apply pressure to the ends of the rotor shafts with the center screws or the nuts on the threaded rods. The pressure should be applied equally to each shaft.
15. **Series 31/33/90/91** - After the end plate is removed, tap out bearings (9), and mechanical seals (76A & 76B). Remove retainer rings (219) and tap out the labyrinth seals (51).
    Series 35/37/92/93 - After the end plate is removed, tap out bearings (9) and seals (12). Remove retainer rings (219). Oil slingers (238) will come out with the bearings. Do not remove oil retainers (79) unless they are damaged or end plate is to be replaced.
16. Reinstall the end plate, without the bearings, and secure with six cap screws. Turn the booster over and support with blocks under the gear end plate.
17. Remove end plate cap screws (26). Remove end plate using same tools used to remove gear end plate. Remove the bearings and seal parts. Discard all O-rings (233) and (176). Retain mechanical seal spacers (55) for reassembly 31/33/90/91 series only.
18. Lift the rotors out of the housing. Unbolt the gear end plate and lift the housing (2) off.
19. Wash and inspect all parts for wear and serviceability.

NOTE
On pressure lube units, each bearing is supplied oil through a small orifice fitting in the end plates and gear cover. It is necessary to remove them but make sure they are not plugged by checking with compressed air.

8.2 ASSEMBLY

The assembly procedure is generally the same for all series, but where there are differences, notations will be made. All joints between housing and port fittings, and end plates and end covers must be sealed with an RTV Silicone sealer or equal. Dowel pins are used to locate end plates, housing, and covers in the proper location relative to each other. Be sure they are in place. It is recommended that the gear end rotor shaft bearings be purchased from Kinney, as they are specially ground to locate the rotors with correct end clearance relative to the gear end plate.

8.2.1 PREPARATION OF END PLATES

1. Make sure all parts are clean and free of any nicks or burrs caused by disassembly. See Figure 13 and Figure 15 on page 33 for dimensions of seal pressing tools.
2. **Series 31/33/90/91** - Position end plates with bearing bores up. Press the labyrinth seals (51) into seal bores of both end plates. Install retainer rings (219). Apply thin coat of sealer to O.D. of seal (76B) and press into seal bore with carbon up. On the free end plate be sure the spacers (55) are in place before installing the seals. If no press is available the bearing pressing plate, Figure 14 can be used. Care should be taken that no sealer is left on the carbon. Clean with soft tissue and cleaning agent (acetone) if necessary. Failure to remove will result in leakage.
   Series 35/37/92/93 - No subassembly required unless you are replacing the oil retainers (79). Press them into the bores until seated. No sealer required.

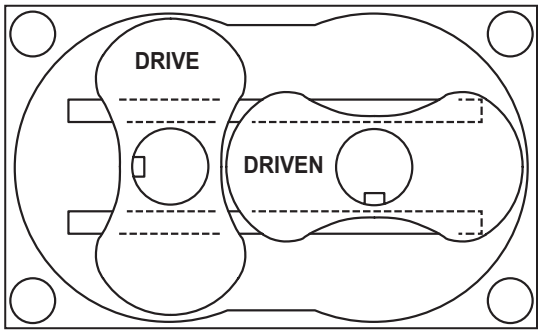


Figure 8 - Keyways

8.2.2 GEAR END ASSEMBLY

3. Place free end plate (4) with flat side up on a pair of 4×4's. The end plate must be blocked up so the rotor shafts will not touch the floor when they are installed. Do not install O-rings at this time. Set

housing (3) in place, being sure dowel pins are installed. Do not bolt at this time.

4. Lay two pieces of 1/8” thick shims on the end plate at the bottom of the housing, parallel to the two rotor shaft bores. Set each rotor into position in the housing, with the gear end (long shaft) up. Face keyways in the direction shown in Figure 8. This will position the rotors so they will match the keyways in the gears. Because of the shims at the bottom of the housing, the rotor lobes will be above the end of the housing, which is necessary when assembling the gear end.
5. Grease four O-rings (233) and one O-ring (176) and install on gear end plate. Install end plate.
6. Bolt the housing to the gear end plate and pull it up tight. Use six bolts, equally spaced and secure free end plate against shims at bottom end of rotors. Hand tighten only.
7. **Series 31/33/90/91** - Clean the lapped surface of the mating rings (76A) with soft tissue and acetone being careful not to nick or scratch the surface. Place a few drops of lubricating oil on the surface and on the O-ring and carefully slide over the rotor shaft while aligning the slot in the mating ring with the spring pin (300) in the rotor shaft.
   Series 35/37/92/93 - Install oil slinger (238) and align slot with pin (300). Install retainer ring (219). Using tool shown in Figures 17 & 18, install lip seal (12) with lip facing bearing.
8. 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 a bearing pressing fixture shown in Figure14
9. Loosen bolts holding free end plate to housing then install bearing retainer rings (14) and secure with cap screws (62). At this time check clearance between rotor lobes and gear end plate. See assembly drawings for correct gear end clearances. If clearances are not within specification, recheck parts to find cause of improper clearances before proceeding
10. Install keys (24) in rotor shafts. Tight fit required. Coat shafts and keys with anti-seize. If new gears are being installed, disassemble the two-piece gear.
11. Heat the solid gear and the hub of the two-piece gear to 350° F (177° C). At this temperature they should fit easily on the rotor shafts. Secure with rotor shaft washers (25) and cap screws (29). Do not install gear shell at this time, allow to cool.

CAUTION

Handle the heated gear and hub with insulated gloves only.

8.2.3 FREE END ASSEMBLY

12. Retighten six free end plate screws by hand. Turn assembly over and support it on blocks, free end up.
13. Remove the six screws and put jackscrews in holes provided in flange of end plate and remove plate. Take out the two 1/8” shims, and check clearances between end of lobes and housing using a flat bar and feeler gauges or a depth micrometer. Refer to assembly drawings for free end clearances.
14. Grease and install O-rings (233) and (176). Reinstall end plate and secure with cap screws (26).
15. Install seals or oil slingers using same procedure as in step 7.
16. Install bearings using same procedure as in step 8. Install bearing retainer rings (220), oil retainer rings (15), and cap screws (62).
17. Install mounting feet (304) with cap screws (307) and stand assembly on its feet. For horizontal flow units you may prefer to lay unit on its side with the drive gear to the left. This will make it easier to take the interlobe readings later. Install the gear shell to the hub, making sure the timing shim (16) is in place, and bolt it tight.

NOTE

As the second gear is installed, the helical teeth will cause the rotor to turn, and unless the rotor lobes are in an open position they will jam. To avoid jamming, rotate the installed gear until the timing mark is at center and then install the second gear with its timing mark matched to the timing mark on the installed gear.

8.2.4 ADJUSTING INTERLOBE CLEARANCE

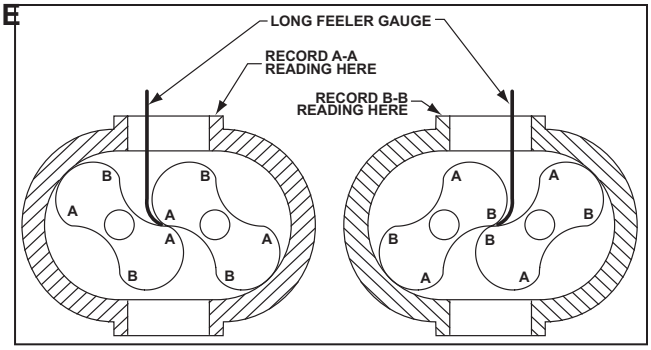


Figure 9 - Rotor Interlobe Clearance

18. The outer gear shell is fastened to the inner hub with four cap screws and located with two dowel pins. Adding or removing shims between the gear shell and the inner hub moves the gear shell axially. The helix causes the gear to rotate which changes the clearance between rotor lobes. Adding .030" (.76 mm) shim thickness will change the rotor lobe clearance by approximately .009" (.23 mm). The timing shim is formed from a number of .003" (.08 mm) shims, which have been laminated together. They are easily peeled off as necessary. Use feeler gauges to check the clearance at AA (right hand reading) and BB (left hand reading). See Figure 9. The clearances should be adjusted so they are as equal between all lobes as possible. Usually within .002" (.05 mm) to .003" (.08 mm). For best results use feeler gauges no larger than .006" (.15 mm).

    EXAMPLE: If AA reading is .020" (.50 mm) and BB reading is .008" (.20 mm), by removing .021" (.53 mm) shims the readings will change .006" (.15 mm). AA should then read .014" (.35 mm) and BB should read .014" (.35 mm). Remember to place timing marks on center and Figure 10 Timing Marks Matched Figure 11 Timing Marks Advanced 3 Teeth (Reference Marks Aligned)

8.2.5 COMPLETE DRIVE END ASSEMBLY

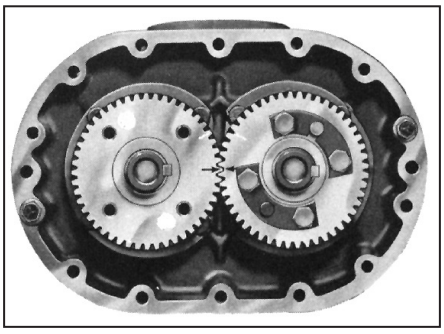


Figure 10 - Keyways in line and timing marks matched

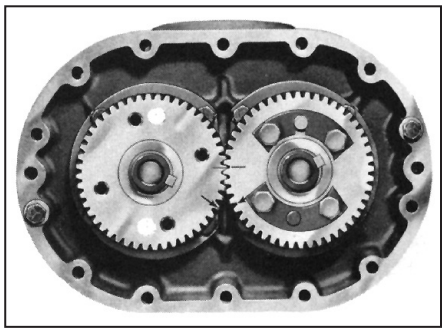


Figure 11 - Timing marks advanced 3 teeth (Reference marks aligned)

19. Clean and remove all burrs from mating surfaces of the gear and drive shaft. Install with cap screws (66). Check drive shaft runout at seal journal. Do not exceed .003" (.08 mm) T. I. R.
20. Install drive shaft bearing (50) and retaining ring (47). If this is a top drive unit install oil slinger (395) and washers (25) at this time.
21. To aid in the installation of the cover (6) a tool as shown in Figure 15 should be made to hold the outer race of the bearing square with the shaft. Put sealer on the end plate and slide the cover over the tool and secure with cap screws (26).
22. Press seal (76B) into seal housing (91) and install O-ring (92). Clean carbon surface and lapped surface of mating ring with soft tissue and acetone. Place a few drops of lubricating oil on mating ring and O-ring (314) and carefully slide over shaft aligning slot with pin (255). Install retaining ring (78). Install seal housing (91) and secure with cap screws (62). Grease and install O-rings (140 & 279). Install water cooling housing (278).
23. Install spacer (197) or adapter (449), oil slinger (20) and secure with cap screws (69).
    Series 31/33/35/37 - Install 11-tooth sprocket on shaft but do not tighten setscrew at this time.
24. Apply sealer to end plate and install cover (7) and secure with cap screws (26).
25. **Series 31/33/35/37** - If oil pump is not being replaced and was not disassembled from bracket, proceed to step C.
    a. Place oil pump mounting bracket (125) on work table with flat surface up. Slide oil pump through pilot hole from angled side (side with 2 mounting holes) of bracket. Make sure the suction side of the pump is to the right. There is an "S" embossed on the pump housing. The "S" should appear at four o'clock when installed properly. Secure with cap screws (309) and lockwashers (117).
    b. Mount sleeve (306) to pump shaft and position with tool no. T70547 Figure 17 and secure to flat of pump shaft with two setscrews (122). Install key (337) and 23 tooth sprocket (452). Position with

same tool used for sleeve and secure with both set screws.

c. Press bearing (362) into bearing carrier (447). Lubricate journal and install on mounting bracket using four screws (321) alternately to draw the carrier into place.
d. Press bearing (362) into bearing carrier (447). Lubricate journal and install on mounting bracket using four screws (321) alternately to draw the carrier into place.
e. Loosen mounting bracket and add necessary shims to take slack out of chain. Align upper sprocket and secure with both set screws. Add additional shims if necessary but do not force. This will allow sufficient slack
f. Reconnect oil hose. Mount pump cover (446) and cover plates (303 & 323) with O-rings (325).

26. Apply sealer to housing and install port fittings (38). Install cooler, oil filte , and external oil lines on units with lube systems.

9. TROUBLESHOOTING

Although Kinney 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 not tightened properly.	Tighten gear housing bolts.
	Lip seal failure.	Disassemble and replace lip seal.
	Insufficient sealant.	Remove gear housing and replace sealant. See the *Disassembly* section.
	Loose drain plug.	Tighten drain plug.
Excessive bearing or gear wear	Improper lubrication.	Correct oil level. Replace dirty oil. See the *Lubrication* section.
	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 the *Assembly Clearances* section.
	Speed too low.	Increase booster 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 the *Disassembly* section.
Excessive booster temperature	Too much or too little oil in gear reservoir.	Check oil level. See the *Lubrication* section.
	Too low operating speed.	Increase booster speed within limits.
	Clogged filter or silencer.	Remove cause of obstruction.
	Excessive pressure differential.	Reduce pressure differential across the booster.
	Elevated inlet temperature.	Reduce inlet temperature.
	Worn lobe clearances.	Check for proper clearances. See the *Assembly Clearances* section.
Rotor end or tip drag	Insufficient assembled clearances.	Correct clearances. See the *Assembly Clearances* section.
	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 the *Assembly Clearances* section.
	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 booster loose.	Check mounting and tighten if necessary.
	Piping resonance.	Check pipe supports, check resonance of nearby equipment, check foundation.

10. ASSEMBLY CLEARANCES

Values shown in inches and *millimeters*.

MODEL	GEAR END	FREE END	INTERLOBE	TIP-DOWEL	TIP-PORT
9012	.007 - .010 *.18 - .25*	.010 - .015 *.25 - .38*	.013 - .018 *.33 - .46*	.009 - .013 *.23 - .33*	.013 - .018 *.33 - .46*
9016	.007 - .010 *.18 - .25*	.012 - .017 *.30 - .43*	.013 - .018 *.33 - .46*	.009 - .013 *.23 - .33*	.013 - .018 *.33 - .46*
9020	.007 - .010 *.18 - .25*	.015 - .020 *.38 - .51*	.013 - .018 *.33 - .46*	.009 - .013 *.23 - .33*	.013 - .018 *.33 - .46*
9027	.007 - .010 *.18 - .25*	.020 - .025 *.51 - .63*	.013 - .018 *.33 - .46*	.009 - .013 *.23 - .33*	.013 - .018 *.33 - .46*
9036	.007 - .010 *.18 - .25*	.029 - .034 *.76 - .86*	.013 - .018 *.33 - .46*	.009 - .013 *.23 - .33*	.013 - .018 *.33 - .46*

11. TORQUE CHART

Data shown represents “wet” torque values.

PART DESCRIPTION	TORQUE
CAP SCREW 10-32UNF	3 ft-lb (4 N-m)
CAP SCREW 1/4”-20UNC GR5	6 ft-lb (8 N-m)
CAP SCREW 5/16”-18UNC GR5	13 ft-lb (17 N-m)
CAP SCREW 3/8”-16UNC GR5	23 ft-lb (31 N-m)
CAP SCREW 1/2”-13UNC GR5	57 ft-lb (77 N-m)
CAP SCREW 5/8”-14UNC GR5	113 ft-lb (153 N-m)
CAP SCREW 3/4”-10UNC GR5	200 ft-lb (271 N-m)

RECOMMENDED LUBRICANTS FOR BLOWER AND VACUUM BOOSTERS

Positive displacement blowers and vacuum boosters require proper lubrication for bearings, seals and gears to operate effectively and efficientl . Oil is distributed from the oil reservoir to the critical components by means of oil slingers that are attached to the rotor shaft. In certain models of CP Series blowers, a high-performance grease rated for high temperatures is used on the drive-end bearings.

MD full synthetic lubricants is the only lubricant recommended in M-D Pneumatics® blowers and Kinney vacuum boosters. MD lubricants are specifically formulated using unique additives that provide maximum protection and extend the life of your product over mineral oils or semi-synthetic lubricants.

⚠ WARNING

Do not overfill the oil sumps. Overfilling can result in gear damage or oil leaks.

⚠ CAUTION

Units are shipped without oil in the sumps. Ensure adequate oil has been added before operating.

Oils that are suitable for a wide range of operating temperatures are offered based on model, operating speed and discharge temperature of the product.

FOR OXYGEN-ENRICHED SERVICE

Blowers and vacuum boosters operated in oxygen enriched applications should only use non-flammable, PFPE full synthetic lubricants. Blowers and vacuum boosters used in hydrogen service should only use MD full synthetic oil

NOTE: Oxygen-enriched service only applicable for PD Plus blowers and vacuum boosters.

⚠ CAUTION

M-D Pneumatics and Kinney does not accept responsibility for damage caused by use of lubricants that are not recommended by M-D Pneumatics and Kinney.

MD BLOWER & BOOSTER LUBRICANTS SPECIFICATIONS:				
PRODUCTS	**MD ONE**	**MD PLUS**	**MD MAX**	**MD FG**
VISCOSITY INDEX	150	154	157	141
@40°C, CST	99.1	231.7	340.9	99.3
@100°C, CST	14.4	27.6	37.2	13.9
FLASH POINT °F (°C)	510 (266)	480 (249)	491 (255)	515 (268)
POUR POINT °F (°C)	- 44 (-43)	-49 (-45)	-54 (-48)	-60 (-51)

NOTE: MD One Vapor Pressure: (mm Hg) 100ºF <0.00004; 200ºF <0.00018

MD BLOWER & BOOSTER LUBRICANTS OPTIONS					
MD OIL TYPE	**1 QUART**	**1 GALLON**	**5 GALLON**	**55 GALLON BARREL**	**CASE 12 QUARTS**
MD ONE	16444-MD1-Q	16444-MD1-G	16444-MD1-5G	16444-MD1-B	16444-MD1-Q-C
MD PLUS	16444-MD2-Q	16444-MD2-G	16444-MD2-5G	16444-MD2-B	16444-MD2-Q-C
MD MAX	16444-MD3-Q	16444-MD3-G	16444-MD3-5G	16444-MD3-B	16444-MD3-Q-C
MD FG	16444-MD1-Q-FG	16444-MD1-G-FG	16444-MD1-5G-FG	16444-MD1-B-FG	16444-MD1-Q-C-FG

13. SPECIAL TOOL DRAWINGS

FIGURE 13 —
LABYRINTH SEAL INSTALLATION TOOL

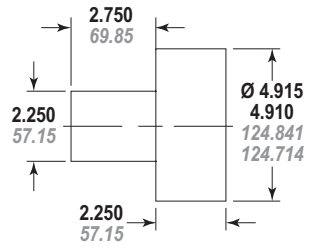


FIGURE 14 —
BEARING INSTALLATION TOOL

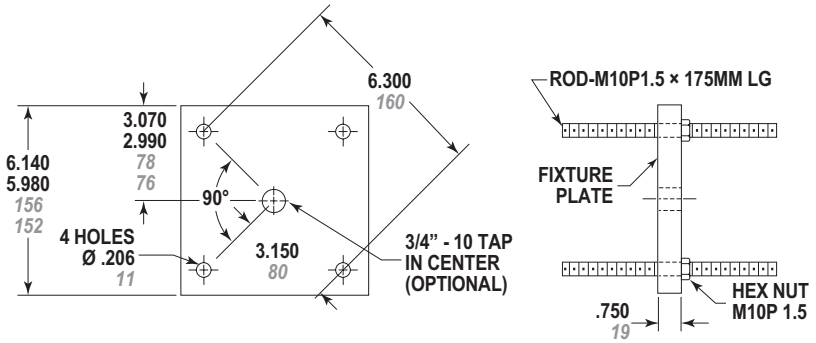


FIGURE 15 —
SEAL INSTALLATION TOOL

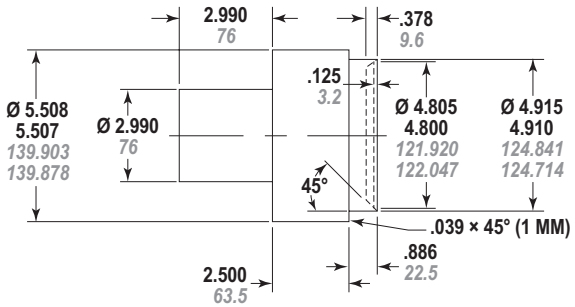


FIGURE 16 —
ALIGNMENT TOOL FOR DRIVE SHAFT BEARING

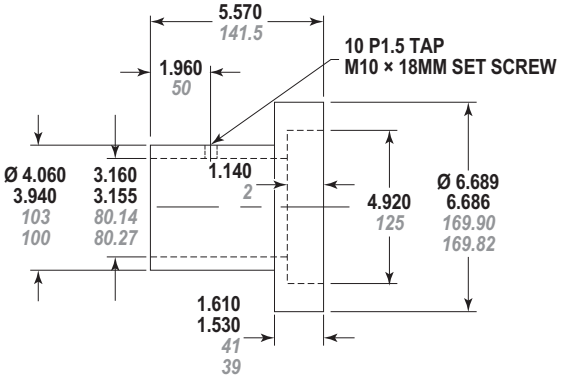


FIGURE 17 —
LIP SEAL INSTALLATION TOOL

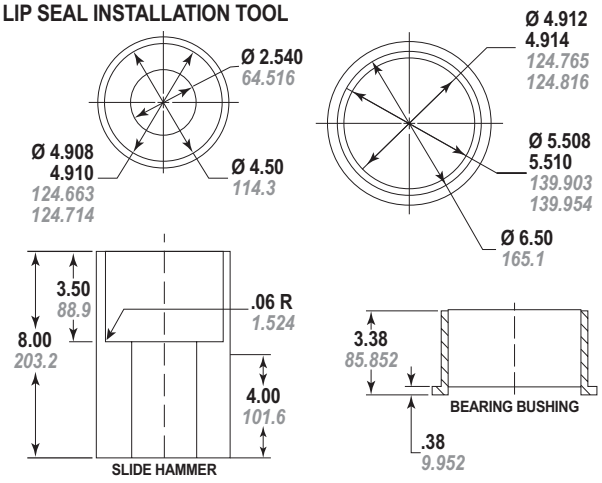
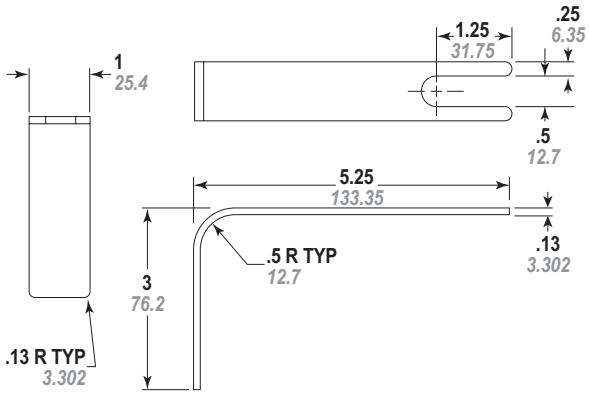


FIGURE 18 —
SLEEVE & SPROCKET INSTALLATION TOOL



NOTE:
All dimensions are shown in Inches and *millimeters*.

MATERIAL:
MILD STEEL

PARTS LIST FOR MODEL 9000 VACUUM BOOSTERS

ITEM NO.	PART DESCRIPTION	90/91	92/93	31/33	35/37
1	ROTOR	2	2	2	2
3	HOUSING	1	1	1	1
4	END PLATE	2	2	2	2
6	DRIVE END COVER	1	1	1	1
7	FREE END COVER	1	1	1	1
8	TIMING GEAR SET	1	1	1	1
9	BEARING	4	4	4	4
12	LIP SEAL	—	4	—	4
14	BEARING RETAINER	2	2	2	2
15	OIL RETAINER RING	2	2	2	2
20	OIL SLINGER	1	1	1	1
22	DOWEL PIN	6	6	6	6
23	DRIVE SHAFT KEY	1	1	1	1
24	GEAR KEY	2	2	2	2
25	ROTOR SHAFT WASHER*	2	2	2	2
26	CAP SCREW	AR	AR	AR	AR
29	CAP SCREW**	8	8	8	8
31	MAGNETIC PIPE PLUG	2	2	2	2
38	PORT FITTING	2	2	2	2
45	DRIVE SHAFT	1	1	1	1
50	BEARING	1	1	1	1
51	LABYRINTH SEAL	4	—	4	—
54	MECHANICAL SEAL	4	—	4	—
55	SEAL SPACER	2	—	2	—
62	CAP SCREW	20	20	20	20
66	SCREW	4	4	4	4
69	CAP SCREW	4	4	4	4
70	OIL SIGHT GLASS	1	1	1	1
76A	SEAL MATING RING	1	1	1	1
76B	SEAL STATOR	1	1	1	1
78	RETAINER RING	1	1	1	1
79	OIL RETAINER (SEAL)	—	4	—	4
91	SEAL ADAPTER HOUSING	1	1	1	1
92	O-RING	1	1	1	1
93	CAP SCREW	4	4	4	4

ITEM NO.	PART DESCRIPTION	90/91	92/93	31/33	35/37
140	O-RING	1	1	1	1
174	PIPE PLUG	AR	AR	AR	AR
176	O-RING	2	2	2	2
195	LIFTING LUG	2	2	2	2
196	CAP SCREW***	4	4	4	4
197	SPACER	1	1	—	—
199	O-RING	2	2	2	2
219	RETAINING RING	4	4	4	4
220	RETAINING RING	2	2	2	2
224	OIL RETAINER PLATE	1	1	1	1
225	CAP SCREW	4	4	4	4
226	LOCKWASHER	4	4	4	4
232	PIPE PLUG	AR	AR	AR	AR
233	O-RING	8	8	8	8
238	OIL SLINGER (SEAL)	—	4	—	4
255	ROLL PIN	4	4	4	4
278	COOLANT BLOCK	1	1	1	1
279	O-RING	1	1	1	1
300	ROLL PIN	1	1	1	1
303	SIDE ACCESS PLATE	—	—	1	1
304	MOUNTING FOOT	4	4	4	4
307	CAP SCREW	8	8	8	8
314	O-RING	1	1	1	1
336	ORIFICE	—	—	5	5
339	FILL PLUG	1	1	1	1
349	PIPE NIPPLE 1/8”	—	—	1	1
351	PIPE NIPPLE 1/8”	—	—	4	4
354	BUSHING	—	—	5	5
395	SLINGER, DRIVE SHAFT (TOP DRIVE ONLY)	1			

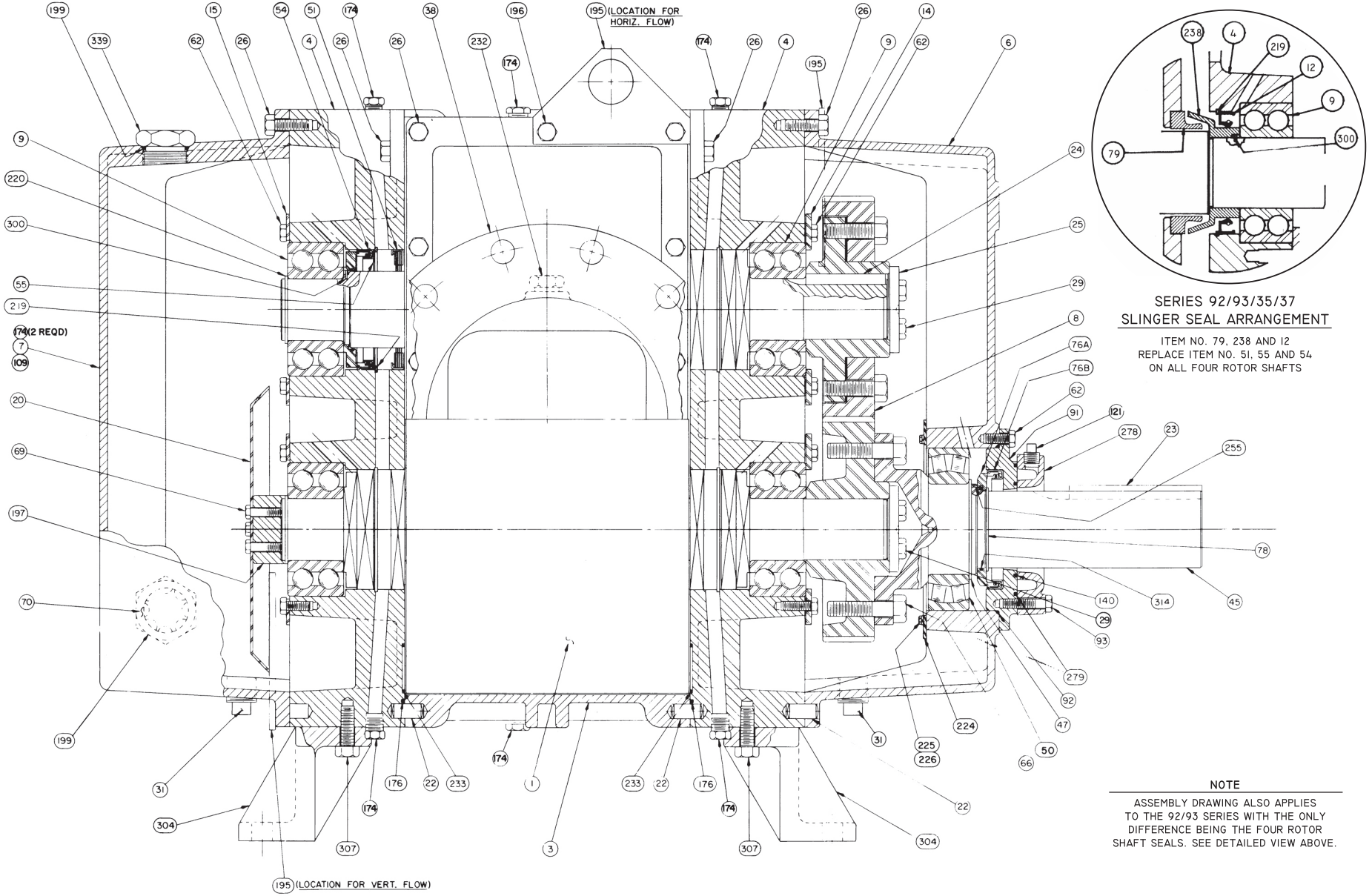
NOTES:

- QUANTITIES SHOWN ARE MAXIMUM VALUES; QUANTITIES MAY VARY BETWEEN BLOWER.
- AR = AS REQUIRED
- * = TOP DRIVE UNITS REQUIRE 3
- ** = TOP DRIVE UNITS REQUIRE 4
- *** = TOP DRIVE UNITS REQUIRE 8

PARTS KITS ARE AVAILABLE, AS FOLLOWS:

90/91 — P/N 30396 92/93 — P/N 30397
31/33 — P/N 70625 35/37 — P/N 70626

CUTAWAY VIEW FOR MODEL 9000-90/91 VACUUM BOOSTERS



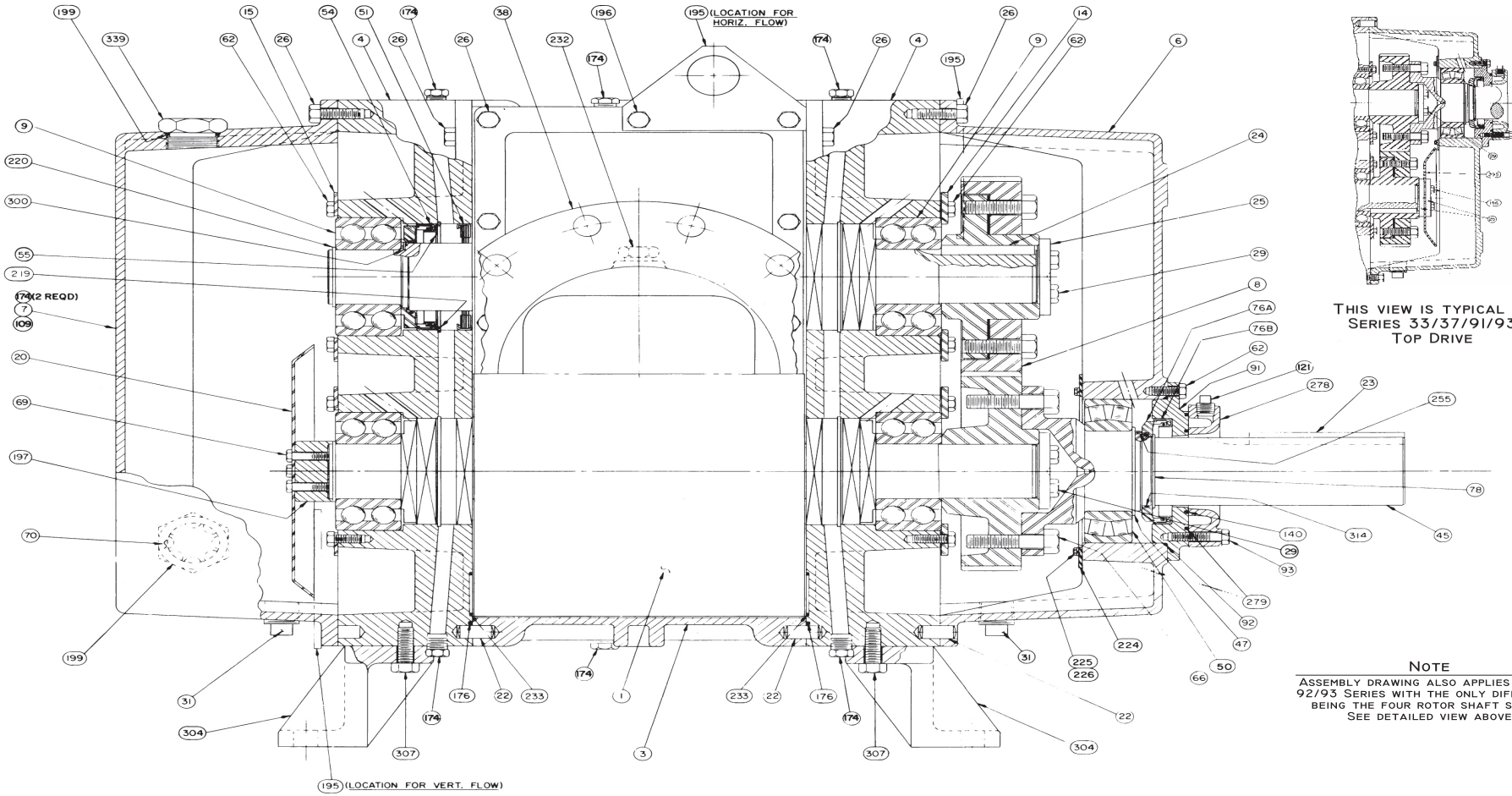
SERIES 92/93/35/37
SLINGER SEAL ARRANGEMENT

ITEM NO. 79, 238 AND 12
REPLACE ITEM NO. 51, 55 AND 54
ON ALL FOUR ROTOR SHAFTS

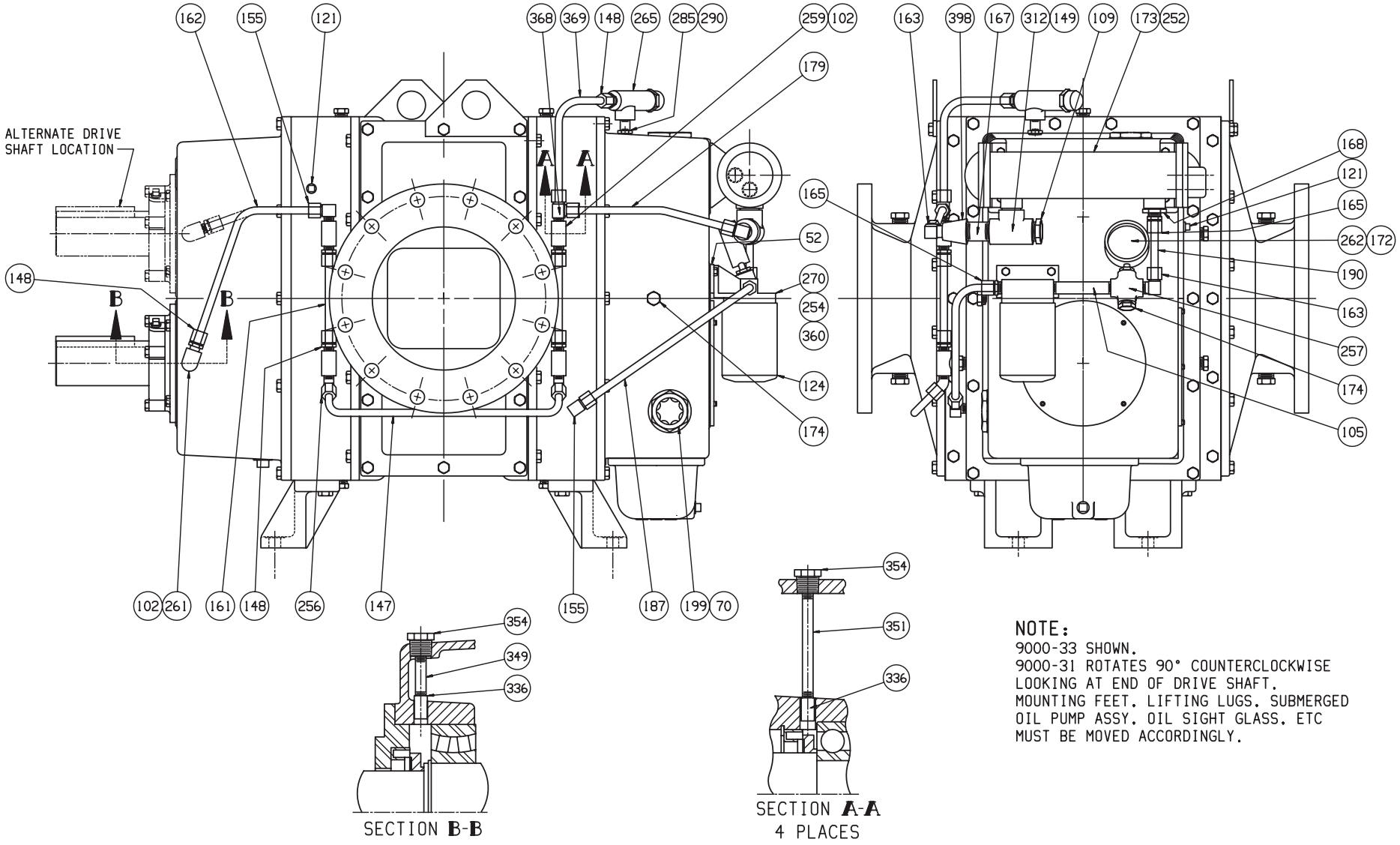
NOTE

ASSEMBLY DRAWING ALSO APPLIES TO THE 92/93 SERIES WITH THE ONLY DIFFERENCE BEING THE FOUR ROTOR SHAFT SEALS. SEE DETAILED VIEW ABOVE.

CUTAWAY VIEW FOR MODEL 9000-31/33 VACUUM BOOSTERS



ASSEMBLY DRAWING FOR MODEL 9000-31,35,90,92,33,37,91,93 VACUUM BOOSTERS



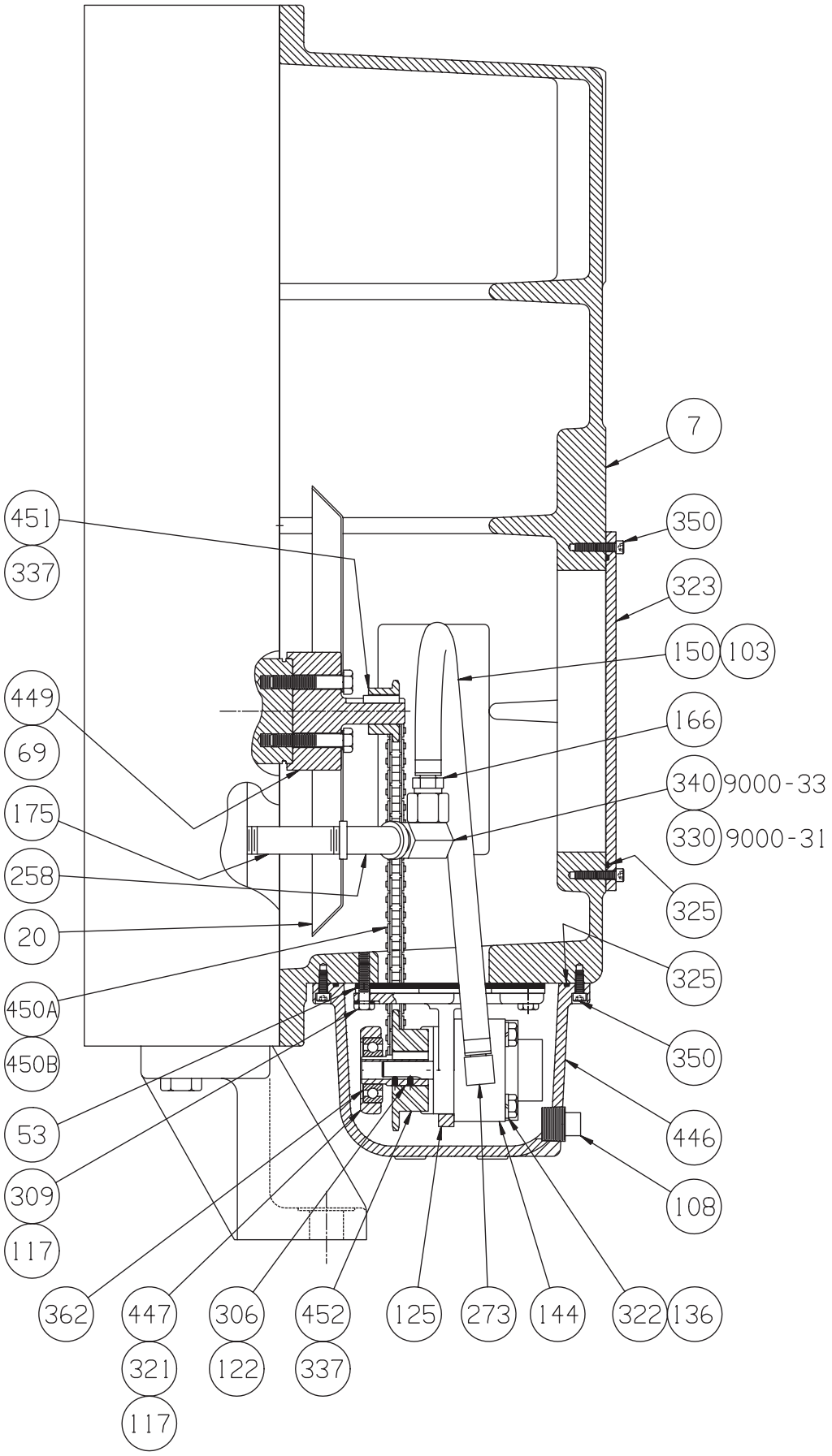
NOTE:
9000-33 SHOWN.
9000-31 ROTATES 90° COUNTERCLOCKWISE LOOKING AT END OF DRIVE SHAFT. MOUNTING FEET. LIFTING LUGS. SUBMERGED OIL PUMP ASSY. OIL SIGHT GLASS. ETC MUST BE MOVED ACCORDINGLY.

PARTS LIST FOR MODEL 9000 BOOSTERS WITH SUBMERGED OIL PUMP ASSEMBLY

ITEM NO.	PART DESCRIPTION	31/33	35/37
103	HOSE CLAMP	2	2
108	MAGNETIC PLUG	1	1
117	LOCKWASHER	7	7
122	SET SCREW	2	2
125	MOUNTING BRACKET	1	1
136	LOCKWASHER	4	4
144	OIL PUMP	1	1
150	HOSE	1	1
166	BARBED CONNECTION	1	1
175	PIPE NIPPLE	1	1
258	ELBOW	1	1
273	BARBED CONNECTION	1	1
306	SHAFT SLEEVE	1	1
309	CAP SCREW	3	3
321	CAP SCREW	4	4
322	CAP SCREW	4	4
323	FRONT ACCESS PLATE	1	1
325	O-RING	3	3
330	SWIVEL ADAPTER*	1	1
337	KEY	2	2
340	SWIVEL ADAPTER**	1	1
350	CAP SCREW	16	16
362	BEARING	1	1
446	COVER	1	1
447	BEARING CARRIER	1	1
449	ADAPTER	1	1
450A	ROLLER CHAIN	1	1
450B	CONNECTOR LINK	1	1
451	SPROCKET	1	1
452	SPROCKET	1	1

NOTES:
- QUANTITIES SHOWN ARE MAXIMUM VALUES; QUANTITIES MAY VARY BETWEEN BLOWER.
- * = USED ON 31 AND 35 SERIES ONLY.
- ** = USED ON 33 AND 37 SERIES ONLY.

ASSEMBLY DRAWING FOR MODEL 9000 BOOSTERS
WITH SUBMERGED OIL PUMP ASSEMBLY



WARRANTY – VACUUM PRODUCTS

Subject to the terms and conditions hereinafter set forth and set forth in General Terms of Sale, Kinney (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	WARRANTY DURATION
New (Non-Piston Pumps)	15 months after date of shipment or 12 months after initial startup date, whichever occurs firs
New (Piston Pumps)	30 months after date of shipment, on all units sold after June 1, 2014.
Repair	6 months after date of shipment or remaining warranty period, whichever is greater
Remanufactured	9 months after date of shipment or 6 months after initial startup date, whichever occurs firs

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.

June, 2014

OPERATING DATA FORM / PRODUCT REGISTRATION

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 vacuum booster, vacuum pump or the system. This information is also helpful when ordering spare parts.

Model No. _____ V-Belt Size _____ Length _____

Serial No. _____ Type of Lubrication _____

Startup Date _____ _____

Pump RPM _____ Operating Vacuum _____

Pump Sheave Diameter _____ Any other Special Accessories Supplied or in use:

Motor Sheave Diameter _____ _____

Motor RPM _____ HP _____ _____

NOTES: _____

_____

_____

_____

IMPORTANT

All vacuum boosters and vacuum pumps manufactured by Kinney 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. You may also register your product online at www.kinneyvacuum.com or contact Customer Service.

KINNEY®

For Service & Repair, Technical Support, or Product Sales contact:

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Springfield, Missouri USA 65803-8702
O 417.865.8715 800.825.6937
F 417.865.2950
www.kinneyvacuum.com

MEMBER OF CAGI Compressed Air & Gas Institute

AVEM Association of Vacuum Equipment Manufacturers

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