



Measurement

# Universal BLOWER RAI®

Universal RAI-J™

## INSTRUCTIONS ROTARY LOBE BLOWERS

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NUMBERS IN ( ) ARE METRIC EQUIVALENTS

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### DO THESE THINGS To Get The Most From Your ROOTS™ blower

- 1** Check shipment for damage. If found, file claim with carrier and notify Sales Office.
- 2** Unpack shipment carefully, and check contents against Packing List. Notify Sales Office if a shortage appears.
- 3** Store in a clean, dry location until ready for installation, if possible. Lift by methods discussed under INSTALLATION to avoid straining or distorting the equipment. Keep covers on all openings. Protect against weather and corrosion if outdoor storage is necessary.
- 4** Read LIMITATIONS and INSTALLATION sections in this manual and plan the complete installation.
- 5** Provide for adequate safeguards against accidents to persons working on or near the equipment during both installation and operation. See SAFETY PRECAUTIONS.
- 6** Install all equipment correctly. Foundation design must be adequate and piping carefully done. Use recommended accessories for operating protection.
- 7** Make sure both driving and driven equipment is correctly lubricated before start-up. See LUBRICATION.
- 8** Read starting check points under OPERATION. Run equipment briefly to check for installation errors and make corrections. Follow with a trial run under normal operating conditions.
- 9** In the event of trouble during installation or operation, do not attempt repairs of Roots furnished equipment. Notify Sales Office or factory, giving all nameplate information plus an outline of operating conditions and a description of the trouble.
- 10** Unauthorized attempts at equipment repair may void Manufacturer's warranty. Units out of warranty may be repaired or adjusted by the owner. It is recommended that such work be limited to the operation described in this manual, using Factory Parts. Good inspection and maintenance practices should reduce the need for repairs. See Sales Office list on last page for parts and service after warranty period.

NOTE - Information in this manual is correct as of the date of publication. The Manufacturer reserves the right to make design or material changes without notice, and without obligation to make similar changes on equipment of prior manufacture.

# OPERATING CHARACTERISTICS

Roots UNIVERSAL RAI® and UNIVERSAL RAI-J™ blowers, as covered in this manual, are designated as air blowers, and may be used for handling air in either pressure or vacuum service. They are unsuitable for handling gases because shaft seals are not designed to prevent leakage to atmosphere.

The Roots rotary lobe blower is a positive displacement type unit, whose pumping capacity is determined by size, operating speed and pressure conditions. It employs two double-lobe impellers mounted on parallel shafts and rotating in opposite directions within a cylinder closed at the ends by headplates. As the impellers rotate, air is drawn into one side of the cylinder and forced out the opposite side against the existing pressures. The differential pressure developed, therefore, depends on the resistance of the connected systems.

Effective sealing of the blower inlet area from the discharge area is accomplished by use of very small operating clearances. Resulting absence of moving contacts eliminates the need for any internal lubrication. Clearances

between the impellers during rotation are maintained by a pair of accurately machined timing gears, mounted on the two shafts extending outside the air chamber.

Operation of the familiar basic rotary lobe blower is illustrated in FIGURE 1, where air flow is right to left from inlet to discharge with the bottom impeller rotating clockwise. In Position 1 it is delivering a known volume (A) to the discharge, while space (B) between the upper impeller and cylinder wall is being filled. Counterclockwise rotation of this impeller then traps equal volume (B) in Position 2, and further rotation delivers it to the discharge in Position 3. At the same time, another similar volume is forming under the lower impeller, and will be discharged when rotation reaches Position 1 again.

One complete revolution of the driving shaft alternately traps four equal and known volumes of air (two by each impeller) and pushes them through to the discharge. The pumping capacity of a lobe blower operating at a constant speed therefore remains relatively independent of reasonable inlet or discharge pressure variations. To change capacity, it is necessary either to change speed of rotation or vent some of the air.

No attempt should ever be made to control capacity

CONVENTIONAL BLOWER OPERATING PRINCIPLE

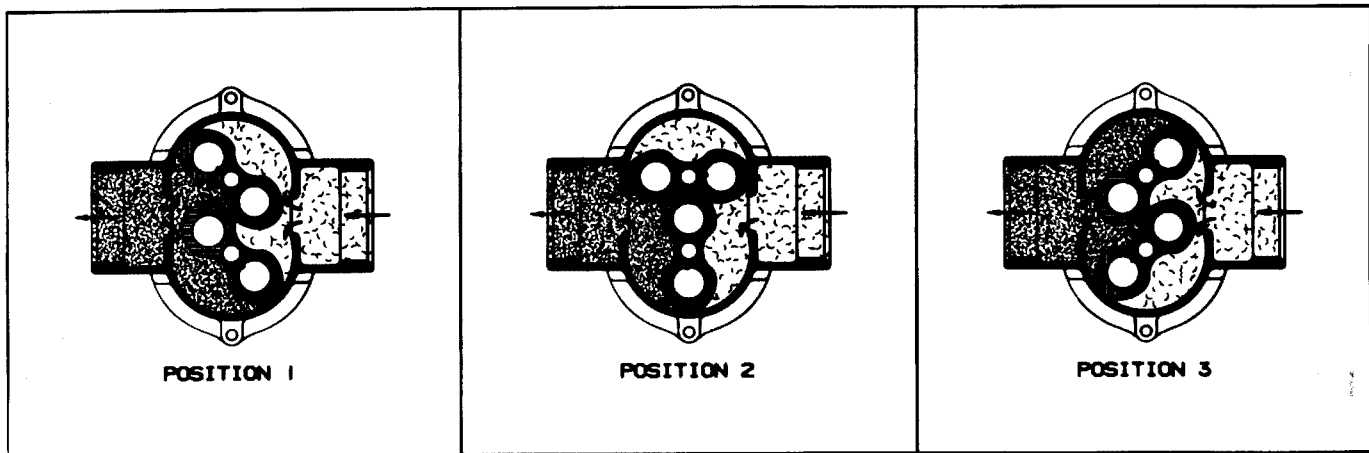


Figure 1 – Flow Through a Basic Type U-RAI® blower

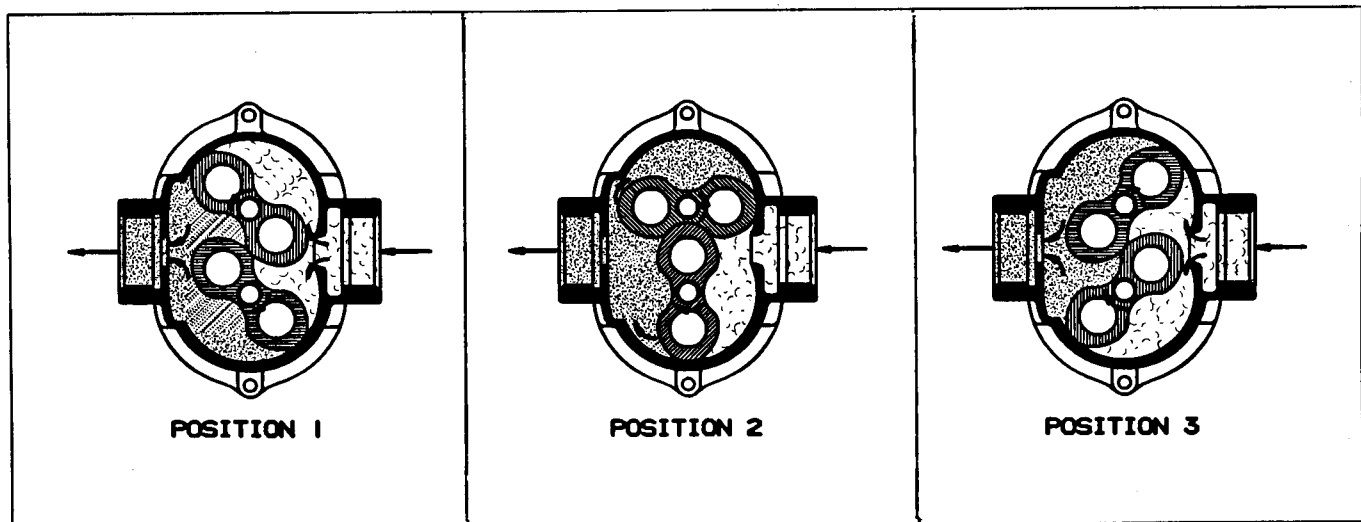


Figure 1A – Blower Operating Principle with Slot Jet U-RAI®

by means of a throttle valve in the intake or discharge piping. This increases the power load on the driver, and may seriously damage the blower. Likewise, if a possibility exists that flow to the blower inlet may be cut off during normal operation of a process, then an adequate vacuum relief valve must be installed near the blower. A pressure type relief valve in the discharge line near the blower is also strongly recommended for protection against cut-off or blocking in this line.

When a belt drive is employed, blower speed can usually be adjusted to obtain desired capacity by changing the diameter of one or both sheaves. See pages 18, 19, and 21 for minimum sheave diameter. In a direct coupled arrangement, a variable speed motor or transmission is required, or air may be vented through a manually controlled unloading valve and silencer. If discharge air is returned to the blower inlet, it must be cooled to 100°F (38°C) through a cooling by-pass arrangement.

Before making any change in blower capacity or operating conditions, contact the nearest Distributor for specific information applying to your particular blower. In all cases, operating conditions must be maintained within the approved range of pressures, temperatures and speeds as stated under **LIMITATIONS**. Also, the blower must not be used to handle air containing liquids or solids, or serious damage to the rotating parts will result.

## OPERATING LIMITATIONS

To permit continued satisfactory performance, a ROOTS™ UNIVERSAL RAI® blower 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 in Table 1 for various sizes of UNIVERSAL RAI® blowers. These limits apply to all blowers of normal construction, having operating clearances as listed in Table 6 when operated under standard atmospheric conditions. **Do not exceed any of these limits.**

Table 1 – Maximum Allowable Operating Conditions

Frame Size	Speed RPM	Inlet Vac. Inches Hg. (kPa)	Temp. Rise Fahr. Deg. (C°)	Press. Rise PSI (kPa)
22	5275	15 (50)	225 (125)	12 ( 82)
24	5275	15 (50)	210 (117)	7 ( 47)
32	3600	16 (53)	240 (133)	15 (101)
33/33J	3600	15 (50)	225 (125)	12 ( 82)
36/36J	3600	15 (50)	225 (125)	7 ( 47)
42	3600	16 (53)	240 (133)	15 (101)
45/45J	3600	16 (53)	225 (125)	10 ( 68)
47/47J	3600	15 (50)	225 (125)	7 ( 47)
53	2850	16 (53)	225 (125)	15 (101)
56/56J	2850	16 (53)	225 (125)	13 ( 88)
59	2850	15 (50)	225 (125)	7 ( 47)
65	2350	16 (53)	250 (130)	15 (101)
68	2350	16 (53)	240 (133)	14 ( 95)
615	2350	14 (46)	130 ( 72)	7 ( 46)
76	2050	16 (53)	250 (139)	15 (101)
711	2050	16 (53)	225 (125)	10 ( 68)
718	2050	12 (40)	130 ( 72)	6 ( 40)

**Example:** The listed maximum allowable temperature rise (increase in air temperature between inlet and discharge) for any particular blower may occur well before its maximum pressure or vacuum rating is reached. This can easily occur at high altitude or at very low speed. Temperature rise then is the limiting condition. In other words, the operating limit is always determined by the maximum rating reached first. It can be any one of the three: pressure, temperature or speed.

Be sure to arrange connections or taps for thermometers and mercury type pressure or vacuum gauges at or near the inlet and discharge connections of the blowers. These, along with a good tachometer, will enable periodic checks of operating conditions to be made easily.

**PRESSURE** – On pressure service, the pressure rise in pounds per square inch (kPa) (between blower inlet and discharge) must not exceed the figure listed for the specific blower frame size concerned. Also, in any system where the blower inlet is at a positive pressure above atmosphere, the discharge pressure must never exceed 25 PSI (172 kPa) gauge regardless of blower size.

On vacuum service, with the discharge going to atmospheric pressure, the inlet suction or vacuum in inches of mercury (Hg.) (kPa) must not be greater than the values listed for the specific frame size.

**TEMPERATURE** – Various blower frame sizes are approved only for installations where the following temperature limitations can be maintained in service.

- A. Measured temperature rise in Fahrenheit degrees (C°) must not exceed listed values when the inlet is at ambient temperature. Ambient is considered as the general temperature of the space around the blower. This is not outdoor temperature unless the blower is installed outdoors.
- B. If inlet temperature is higher than ambient, the listed allowable temperature rise values must be reduced by 2/3 of the difference between the actual measured inlet temperature and the ambient temperature.
- C. Average of inlet plus discharge temperature must not exceed 250°F (139°C).

**SPEED RANGE** – UNIVERSAL RAI® blowers may be operated at speeds up to the maximums listed for various frame sizes. They may be direct coupled to suitable constant speed drivers if pressure/temperature conditions are also within limits. At low speeds, excessive temperature rise may be the limiting factor as noted in the preceding example.

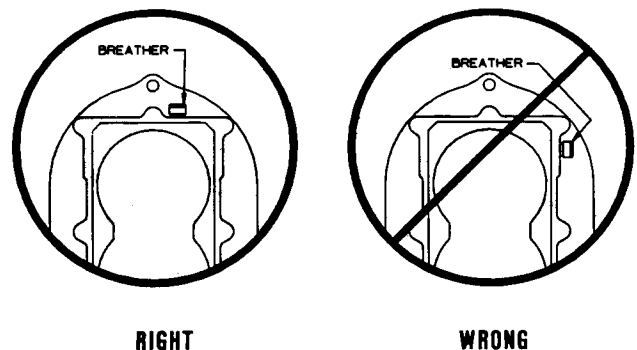


Figure 2 – Breather Installation

# BLOWER ORIENTATION

The unique removable feet feature of ROOTS™ UNIVERSAL RAI® blowers permit field modification of blower mounting by repositioning blower feet and gear box breather as shown in Figure 3.

Four blower mounting positions are possible:

1. Horizontal mounting, vertical air flow, drive shaft on left.
2. Same as (1) except drive shaft on right.
3. Vertical mounting, horizontal air flow, drive shaft on bottom.
4. Same as (3) except drive shaft on top.

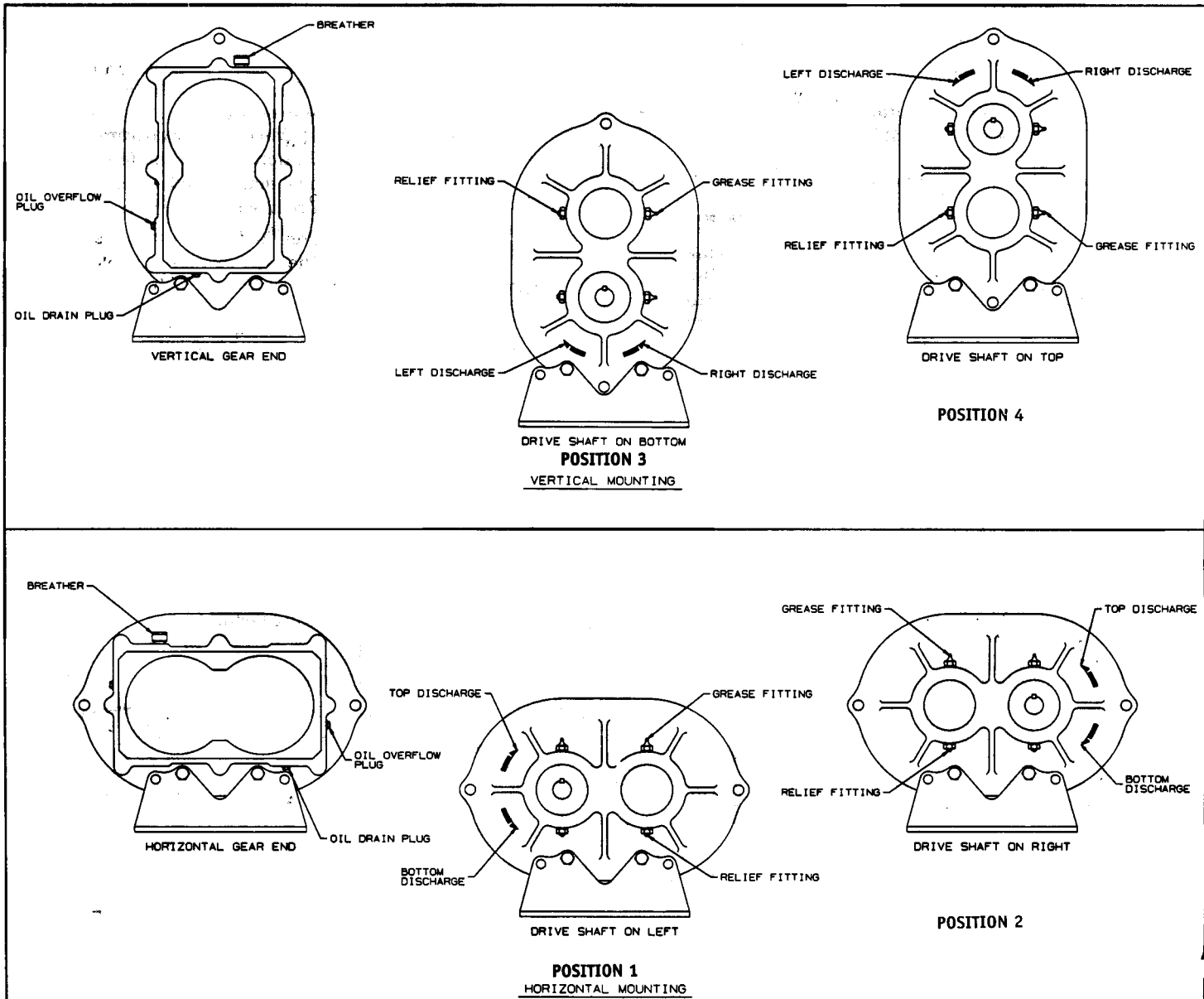
\*To change blower mounting:

1. Place blower on its feet.
2. Loosen feet capscrews (32).
3. Place blower on a solid base resting on the gear box end with drive shaft on top.
4. Remove feet. (Note – Feet capscrews (32) are longer

than cylinder capscrews (26), only capscrews (32) are to be used for feet.)

5. Remove cylinder capscrews (32) where feet are to be re-installed. Install capscrews (26) in the location previously occupied by feet capscrews (32).
6. Install feet using capscrews (32).
7. Place blower on its feet on flat surface.
8. Loosen feet capscrews (32) and square up blower and re-tighten capscrews (32).
9. Gear box has four threaded holes, one with breather and three with pipe plugs. Remove pipe plug (21) from the top most hole. Remove breather (25) and install it in the top most hole. Install pipe plug that was removed from the top hole into the hole previously occupied by the breather. The breather and the pipe plug should be sealed with a thread sealer.

For convenience, the position of the grease fitting (37) and the relief fitting (38) could be interchanged, however each bearing must have one grease fitting (37) and one relief fitting (38).



Insert Figure 3 – Blower Orientation and Lubrication Points

# INSTALLATION

ROOTS™ UNIVERSAL RAI® blowers are internally and externally treated after factory assembly to protect against normal atmospheric corrosion before installation. Maximum period of internal protection is considered to be one year under average conditions, if closing plugs or seals are not removed. **Protection against chemical or salt water atmosphere is not provided.** Avoid opening the blower until ready to start installation, as protection will be lost quickly by evaporation.

**NOTE** – If there is to be an extended period between delivery (and/or installation) and startup, the following steps should be taken to insure corrosion protection:

1. Coat internals of cylinder and gearbox with Nox-Rust No. VCI10 or equivalent. Repeat once a year or as conditions may require. VCI10 is oil soluble and does not have to be removed before lubricating. If desired, VCI10 may be removed from within the cylinder shortly before startup by spraying a fine mist of petroleum solvent through the blower while it is running at a slow speed with open inlet and discharge, or it can remain in the blower if it is not harmful to the operation of the connected system.
2. Fill drive end bearing cavities with grease as specified in Lubrication section.
3. Paint shaft extension, inlet and discharge flanges, and all other exposed surfaces with Nox-Rust X-110 or equivalent.
4. Seal inlet, discharge, and all vent openings with tape. It is **not** recommended that the unit be set in place, piped to the system, and allowed to remain idle for extended periods. If any part is left open to the atmosphere, the VCI10 vapor will escape and lose its effectiveness.
5. Units are not to be subjected to excessive vibration during storage.
6. Rotate drive shaft three or four revolutions every two weeks.
7. Prior to startup, remove flange covers on both inlet and discharge and inspect internals to insure absence of rust. Check all internal clearances. Also, at this time, remove gearbox and inspect gear teeth for rust.

Because of the completely enclosed blower design, location of the installation is generally not a critical matter. A clean, dry and protected indoor location is to be preferred. However, an outdoor or wet location will normally give satisfactory service. Important requirements are that the correct grade of lubricating oil be provided for expected temperatures, and that the blower be located so that routine checking and servicing can be handled conveniently after installation. Effect of the location on driver and accessory equipment must also be considered.

Supervision of the installation by a Factory Service Engineer is not usually required for these blowers. Workmen with experience in installing light-medium weight machinery should be able to produce satisfactory

results. Handling of the equipment needs to be accomplished with care, and in compliance with safe practices. Blower mounting must be solid, without strain or twist, and air piping must be clean, accurately aligned and properly connected.

A bare blower without base should be lifted by a rope sling, with one loop passing under the gearhouse and the other loop under the cylinder. Lifting lugs (42) are provided on 6" and 7" gear diameter units.

When a blower is furnished mounted on a baseplate, with or without a driver, use of lifting slings passing under the base flanges is required. Arrange these slings so that no strains are placed on the blower casing or mounting feet, or on any mounted accessory equipment.

Before starting the installation, remove plugs, covers or seals from blower inlet and discharge connections and inspect the interior completely for dirt or foreign material. If cleaning is required, finish by washing the cylinder, headplates and impeller thoroughly with a solvent. After this, turn the drive shaft by hand to make sure that the impellers turn freely at all points. Anti-rust compound on the drive shaft extension may also be removed at this time with the same solvent. Then plug the inlet and discharge connections to keep out dirt until ready to connect the air piping. Washing out is not required if the interior is found to be clean. The corrosion inhibitor used will vaporize and disappear during operation.

Care, plus consideration of all possible problems, will pay dividends when arranging the blower mounting. This is especially true when the blower is a "bare" unit furnished without a baseplate. The convenient procedure may be to mount such a unit directly on a floor or small concrete pad, but this generally produces least satisfactory results. It definitely causes the most problems in leveling and alignment.

Direct use of structural framing members is also not a recommended mounting. If unavoidable, the members must be rigidly reinforced when part of a building, and spring type mountings should not be used. Noise transmission can usually be reduced by use of a cork insulating pad 1 to 2 inches (25 to 50 mm) thickness. The pad should be supported by a full steel plate attached to the structure, with a rigid concrete slab laid on top of the cork to carry the blower and driver.

For a blower without base, it is recommended that a well anchored and carefully leveled steel or cast iron mounting plate be provided at the installation point. The plate should be 3/4 to 1-1/4 inches (19 to 32 mm) thick, with its top surface machined flat, and needs to be large enough to provide leveling areas at one side and one end after the blower is mounted. It should have properly sized studs or tapped holes located to match the blower foot drilling. As an alternative, smaller plates at each end of the blower may be used. This is more complicated, usually makes leveling more difficult, and can produce twist or strains in the blower. Use of a high quality machinist's level is important. With the mounting plate in place and leveled, set the blower on it without bolting and check for rocking. If it is not solid, determine the total thickness of shims required under one foot to stop the rocking. Place half of this under each of the two short feet, and tighten the mounting studs or screws. Rotate the drive shaft to make sure the impellers still turn freely. If the blower is to

be direct coupled to a driving motor, consider the height of the motor shaft and the necessity for it to be aligned very accurately with the blower shaft. Best arrangement is for the blower to be bolted directly to the mounting plate while the driver is on shims of at least 1/8 inch (3mm) thickness. This allows adjustment of motor position in final shaft alignment by varying the shim thickness.

Satisfactory installation can be obtained by setting the baseplate on a concrete slab that is rigid and free of vibration, and leveling the top of the base carefully in two directions so that it is free of twist. The slab must be provided with suitable anchor bolts. The use of grouting under and inside the base, after it has been carefully leveled by shimming, is recommended.

When blower and driver have been factory mounted on a common baseplate, the assembly will have been properly aligned and is to be treated as a unit for leveling purposes. It is possible for a base mounted assembly to become twisted during shipment thus disturbing the original alignment. For this reason, make the following checks after the base has been leveled and bolted down. Disconnect the drive and rotate the blower shaft by hand. It should turn freely at all points. Loosen the blower foot hold-down screws and determine whether all feet are evenly in contact with the base. If not, insert shims as required and again check for free impeller rotation. Finally, if blower is direct coupled to the driver, check shaft and coupling alignment carefully and make any necessary corrections prior to grouting.

In planning the installation, and before setting the blower, consider how piping arrangements are dictated by the blower design and assembly.

When a blower is **DIRECT COUPLED** to its driver, the driver RPM must be selected or governed so as not to exceed the maximum speed rating of the blower. Refer to **LIMITATIONS** for allowable speeds for various blower sizes. A flexible type coupling should always be used to connect the driver and blower shafts.

For engine drives, couplings with proper stiffness must be selected to avoid resonant torsional vibrations. Also, safe operating speed must be limited to avoid critical speeds.

Coupling halves must be accurately aligned, and a sufficient gap between shaft ends provided, so that side strains and end thrust on either shaft are avoided or minimized. This will require considerable care in the mounting of the driver. The two shafts must be in as near perfect alignment in all directions as possible, and the gap must be established with the motor armature on its electrical center if end play exists. Coupling halves must be fitted to the two shafts such that they can be worked into place by hand. Maximum deviation in offset alignment of the shafts should not exceed .005" (.13 mm) total indicator reading, taken on the two coupling hubs. Maximum deviation from parallel of the inside coupling faces should not exceed .001" (.03 mm) when checked at six points around the coupling.

#### **CAUTION**

Couplings as well as sheave bushings must have a slight slide fit with the blower shaft such that they can be installed in place by hand. Any force used to install them will change blower end clearances resulting in blower damage. If an interference fit is desired for the coupling, the

coupling hub should be heated and shrunk on the shaft. For engine drives, use "Locktite" between the coupling hubs and the blower/engine shafts and on the threads of the coupling set screws.

When a blower is **BELT DRIVEN**, a proper selection of sheave diameters can usually be made to adapt any standard driver speed to the required blower speed. This flexibility can sometimes lead to operating temperature problems caused by blower speed being too low. Make sure the drive speed selected is within the allowable range for the specific blower size, as specified under **LIMITATIONS**.

Belted drive arrangements usually employ two or more V-belts running in grooved sheaves, and a variety of positions are available for the driver. Installation of the driver is less critical than for direct coupling, but its shaft must be level and parallel with the blower shaft. The driver must also be mounted on an adjustable base to permit installing, adjusting and removing the V-belts. To position the driver correctly, both sheaves need to be mounted on their shafts and the nominal shaft center distance known for the belt lengths to be used.

Install the blower sheave (usually the larger one) so that its inner hub face is not more than 1/4 inch (7 mm) from the bearing end cover. The shaft fit should be such that the sheave can be worked into place by hand. A tight or driving fit can damage a bearing, and may cause internal blower damage by forcing the impeller out of its normal operating position. A loose fit or wobbly sheave will cause vibration, and may result in shaft breakage.

The driver sheave should also be mounted as close to its bearing as possible, and again should fit the shaft correctly. Position the driver on its adjustable base so that 2/3 of the total movement is available in the direction away from the blower, and mount the assembly so that the face of the sheave is accurately in line with the blower sheave. This position minimizes belt wear, and allows sufficient adjustment for both installing and tightening the belts. After belts are installed, adjust their tension in accordance with the manufacturer's instructions. However, only enough tension should be applied to prevent slippage when the blower is operating under load. *Excessive tightening* can lead to early bearing failures.

Failure to properly align the blower and drive sheaves will result in the impeller being forced against one of the headplates during operation causing serious damage to the blower.

In the absence of belt manufacturer's instructions for tensioning, the following procedures may be used.

1. With the belts loose, pull the slack on all of them to the bottom side of the drive.
2. Adjust motor position to tighten belt until they appear to be seating in the sheave grooves.
3. Thump the belts with your fist. If they feel dead, tighten them more until they vibrate and feel springy when struck.
4. Run-in the drive for a short period, after preparing the blower as instructed in a following paragraph. While running, adjust until only a very slight bow appears in the slack side of the belts.
5. Stop the motor and compare the tensions of the individual belts by pressing down firmly with one hand on the top surface. It should be possible to deflect each belt only to the point where its top surface is even with the bottoms of the other undeflected belts.

- A new set of bolts should be first tensioned about 1/3 greater than normal to allow for stretch and wear-in. Before putting the drive into normal operation, increase the tension as obtained above by a small amount. Recheck after each 8 hour operating period during the first 50 hours, and adjust as necessary.

Before operating the drive under power to check initial belt tension, first remove covers from the blower connections. Make sure the interior is still clean, then rotate the shaft by hand. Place a screen over the inlet connection to prevent anything being sucked into the blower while it is operating, and avoid standing in line with the discharge opening. Put oil in the gearhouse per instructions under LUBRICATION.

Before connecting piping, remove any remaining anti-rust compound from blower connections. Piping must be clean and should be sized so that the air velocity will not exceed 75 feet per second (23 m per second). Pipe used should be no smaller than blower connections. In addition, make sure it is free of dirt, scale, cuttings, weld beads, or foreign materials of any kind.

To further guard against damage to the blower, especially when an inlet filter is not used, install a substantial screen of 16 mesh backed with hardware cloth at or near the inlet connections. Make provisions to clean this screen of collected debris after a few hours operation. It should be removed when its usefulness has ended, as the wire will eventually deteriorate and small pieces going into the blower may cause serious damage.

Pipe threads or flanges must meet the blower connections accurately and squarely. Do not attempt to correct misalignment by springing or cramping the pipe. In most cases this will distort the blower casing and cause impeller rubbing. In severe cases it can prevent operation or result in a broken drive shaft. For similar reasons, piping should be supported near the blower to eliminate dead weight strains. Also, installation of flexible connectors or expansion joints is recommended.

Figure 4 represents in diagram form a blower installation with all accessory items that might be required under various operating conditions. Inlet piping should be completely free of valves or restrictions. When a shut-off valve (not shown) cannot be avoided, make sure a full size vacuum relief is installed near the blower inlet. This will protect against blower overload caused by accidental closing.

Need for an inlet silencer will depend on blower speed and pressure, as well as sound-level requirements in the general surroundings. An inlet filter is normally recommended, especially in dusty or sandy locations, for blower protection. A discharge silencer is also normally suggested. Specific recommendations on silencing can be obtained from the nearest Sales Office. Silencers should be mounted as close to blower as possible.

Discharge piping requires a pressure relief valve, and should include a manual unloading valve to permit starting the blower under no-load conditions. Reliable pressure/vacuum gauges and good thermometers at both inlet and discharge are recommended to allow making the important checks on blower operating conditions. If the demand is constant, but somewhat lower than the blower

output, excess may be blown off through the manual unloading valve.

In multiple blower installations when two or more units discharge into a common header, use of check valves is recommended. These should be of a direct acting or free swinging type, with one valve located in each blower discharge line. Properly installed, they will protect against damage from reverse rotation caused by air back-flow through an idle blower.

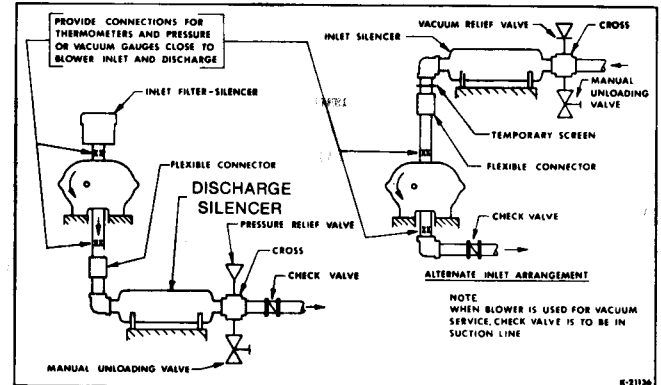


Figure 4 - Installation with Accessories

After piping is completed, and before applying power, rotate the drive shaft by hand again. If it does not move with uniform freedom, look for uneven mounting, piping strain, excessive belt tension or coupling misalignment. Do not operate the blower more than briefly at this time because of possible inadequate oil supply in the gearhouse. Read LUBRICATION section.

## LUBRICATION

A simple but very effective lubrication system is employed on UNIVERSAL RAI® blowers. At the drive shaft end the bearings are grease lubricated using hydraulic pressure relief fittings. These relief fittings vent any excess grease, preventing pressure build-up on the seals. A restriction plug and metering orifice prevent loss of lubricant from initial surges in lubricant pressure but permit venting excess lubricant under steadily rising pressures.

The blind end bearings and timing gears are enclosed by a gearhouse located opposite the drive end of the blower. In a side outlet blower, the lower timing gear functions as an oil slinger, carrying lubricant to the upper timing gear and providing splash lubrication for the bearings. Pressure within the gearbox is vented through the breather vent plug (25).

The above description also applies in general to the top or bottom outlet style blower, the principal difference being that both gears dip into the oil sump.

**Before starting blower**, be sure oil has been put in gearhouse, as **ALL OIL WAS DRAINED FOLLOWING SHOP TESTS**. For recommended lubrication oil see Table 2. Use a good grade industrial type rust, oxidation, and foam inhibited, non-detergent oil such as Mobil DTE BB, Texaco R&O 220, Amoco 220 or equal. Also, Roots synthetic oil has proven to be an excellent lubricant.

Table 2 - Recommended Oil Grades

Ambient Temperature ° F.	Viscosity Range SSU at 100° F.	ISO No.
(°C)	(38°C)	
Above 90° (32°)	1000-1200	320
32° to 90° (0° to 32°)	700-1000	220
0° to 32° (-18° to 0°)	500-700	150
Below 0° (-18°)	300-500	100

To fill the gearbox, remove the breather plug and the oil overflow plug (Fig. 3). Fill the reservoir up to the overflow hole. Place the breather and the overflow plug back into their respective holes.

Table 3 - Oil Sump Capacities

Frame Size	Capacity, Fl. Oz. (Liters)	
	Vertical	Horizontal
22	3.4 (.1)	6.1 (.18)
24	3.4 (.1)	6.1 (.18)
32	8.5 (.25)	16.0 (.47)
33	8.5 (.25)	16.0 (.47)
36	8.5 (.25)	16.0 (.47)
42	12.7 (.37)	22.8 (.67)
45	12.7 (.37)	22.8 (.67)
47	12.7 (.37)	22.8 (.67)
53	16.0 (.47)	27.6 (.82)
56	16.0 (.47)	27.6 (.82)
59	16.0 (.47)	27.6 (.82)
65	28.3 (.84)	52.1 (1.54)
68	28.3 (.84)	52.1 (1.54)
615	28.3 (.84)	52.1 (1.54)
76	32.3 (.96)	59.5 (1.76)
711	32.3 (.96)	59.5 (1.76)
718	32.3 (.96)	59.5 (1.76)

Proper lubrication is usually the most important single consideration in obtaining maximum service life and the most satisfactory operation from the unit. Unless operating conditions are quite severe, a weekly check of gearbox oil level and necessary addition of lubricant should be sufficient. However, oil should be changed after initial 100 hours of operation. Thereafter, a complete oil change normally is made after 1000 operating hours, or less, depending on the type of oil and oil operating temperature.

Shaft bearings at the drive end of the blower are grease lubricated and each bearing housing is equipped with pressure type grease fittings and pressure type relief fittings. When servicing drive end bearings, use a NLGI #2 premium grade, petroleum base grease with high temperature (300° service temperature) and moisture resistance and good mechanical stability. Using a pressure gun, force new lubricant into each drive end bearing housing until traces of clean grease comes out of the relief fitting.

After a long shutdown, it is recommended that the grease relief fittings be removed, the old grease flushed out with kerosene or #10 lubricating oil, drained thoroughly, and bearings refilled with new grease. Be sure grease relief fittings are reinstalled. Grease should be added using hand operated grease gun to the drive end bearings at varying time intervals depending on duty cycle and RPM. Table 4 has been prepared as a general greasing schedule guide based on average operating conditions. More frequent intervals may be necessary depending on the grease operating temperature and under unusual circumstances.

Table 4 - Suggested Bearing Lubrication Intervals

Speed In RPM	Operating Hours Per Day		
	8	16	24
	Greasing Intervals in Weeks		
750-1000	7	4	2
1000-1500	5	2	1
1500-2000	4	2	1
2000-2500	3	1	1
2500-3000	2	1	1
3000 and up	1	1	1

## Operation

Before operating a blower under power for the first time, check the unit and the installation thoroughly to reduce the likelihood of avoidable troubles. Use the following procedure list as a guide, but consider any other special conditions in the installation.

1. **Be certain** that no bolts, tools, rags or dirt have been left in the blower air chamber.
2. **Be certain** that inlet piping is free of debris. If an outdoor intake without filter is used, be sure the opening is located so it cannot pick up dirt and is protected by a strong screen or grille. Use of the temporary protective screen at the blower as described under **INSTALLATION** is strongly recommended.
3. **Recheck** blower leveling, drive alignment and tightness of all mounting bolts if installation is not recent. If belt drive is used, adjust belt tension correctly.
4. Turn drive shaft by hand to make sure impellers still rotate without bumping or rubbing at any point.
5. **Make sure** oil level in blower gearbox is correct.
6. Check lubrication of driver. If it is an electric motor, be sure that power is available and that electrical overload devices are installed and workable.
7. Open the manual unloading valve in the discharge air line. If a valve is in the inlet piping, be sure it is open.
8. Bump blower a few revolutions with driver to check that direction of rotation is correct, and that both units coast freely to a stop.

After the preceding points are cleared, blower is ready for trial operation under "no-load" conditions as set up under Item 7. The following procedure is suggested to cover this initial operating test period.

- a. Start blower, let it accelerate to full speed, then shut off. Listen for knocking sounds, both with power on and as speed slows down.
- b. Repeat above, but let blower run 2 or 3 minutes. Check for noises, and vibrations of 5 mils or greater.
- c. Operate blower for about 10 minutes unloaded. Check oil levels. Feel cylinder and headplate surfaces for development of spots too hot to touch, indicating impeller rubs. Be aware of any noticeable increase in vibration.

Assuming that all trials have been satisfactory, or that necessary corrections have been made, the blower should now have a final check run of at least one hour under normal operating conditions. After blower is re-



started, gradually close the discharge unloading valve to apply working pressure. At this point it is recommended that a good pressure gauge or manometer be connected into the discharge line if not already provided, and that thermometers be in both inlet and discharge lines. Readings from these instruments will show whether pressure or temperature ratings of the blower are being exceeded.

During the final run, check operating conditions frequently and observe the oil levels at reasonable intervals. If excessive noise or local heating develops, shut down immediately and determine the cause. If either pressure rise or temperature rise across the blower exceeds the limit specified in this manual shut down and investigate conditions in the piping system or in the process to which air is being supplied. Refer to the **TROUBLE SHOOTING CHECKLIST** for suggestions on various problems that may appear.

The blower should now be ready for continuous duty operation at full speed. During the first few days make periodic checks to determine whether all conditions remain steady, or at least acceptable. This may be particularly important if the blower is supplying air to a process system where conditions can vary. At the first opportunity, stop the blower and clean the temporary inlet protective screen. If no appreciable amount of debris has collected, the screen may be removed. See comments under **INSTALLATION**. At this same time, verify leveling, coupling alignment or belt tension, and mounting bolt tightness.

Should operating experience prove that blower capacity is a little too high for the actual air requirements, a small excess may be blown off continuously through the manual unloading vent valve. **Never rely on the pressure relief valve as an automatic vent.** Such use may cause the discharge pressure to become excessive and can

### TROUBLE SHOOTING CHECKLIST

TROUBLE	ITEM	POSSIBLE CAUSE	REMEDY
No Air Flow	1	Speed too low	Check by tachometer and compare with speed shown on Roots Order Acknowledgement. Compare actual rotation with Figure 3. Change driver if wrong. Check piping, screen, valves, silencer to assure an open flow path.
	2	Wrong Rotation	
	3	Obstruction in piping	
Low capacity	4	Speed too low	See item 1. If belt drive, check for slippage and readjust tension. Check inlet vacuum and discharge pressure, and compare these figures with specified operating conditions on Order. See item 3. Check inside of casing for worn or eroded surfaces causing excessive clearances.
	5	Excessive pressure	
	6	Obstruction in piping	
	7	Excessive slip	
Excessive Power	8	Speed too high	Check speed and compare with Roots Order Acknowledgement. See item 5. Inspect outside of cylinder and headplates for high temperatures areas, then check for impeller contacts at these points. Correct blower mounting, drive alignment.
	9	Pressure too high	
	10	Impellers rubbing	
Overheating of Bearings, or Gears	11	Inadequate lubrication	Restore correct oil levels in gearbox and lubricate. Check gear oil level. If incorrect, drain and refill with clean oil of recommended grade. See item 5. Check carefully. Realign if questionable. Readjust for correct tension. Speeds lower than the minimum recommended will overheat the entire blower.
	12	Excessive lubrication	
	13	Excessive pressure rise	
	14	Coupling misalignment	
	15	Excessive belt tension	
	16	Speed too low	
Vibration	17	Misalignment	See item 14. See item 10. Check gear backlash and condition of bearings. Scale or process material may build up on casing and impellers, or inside impellers. Remove build-up to restore original clearances and impeller balance. Tighten mounting bolts securely. Determine whether standing wave pressure pulsations are present in the piping. Refer to Sales Office.
	18	Impellers rubbing	
	19	Worn bearings/gears	
	20	Unbalanced or rubbing impellers	
	21	Driver or blower loose	
	22	Piping resonances	

also result in failure of the valve itself. If blower capacity appears to be too low, refer to the **TROUBLE SHOOTING CHECKLIST**. If no help is found there it may be possible to increase the blower speed. Before attempting this change, contact the nearest Distributor for recommendations. Be prepared to furnish data on actual air requirements and operating pressure/temperature conditions.

## VIBRATION ASSESSMENT CRITERIA

With measurements taken at the bearing locations on the housings, an unfiltered vibration of 1.0 in/sec peak is considered an appropriate assessment guide line for rotary lobe blowers rigidly mounted on stiff foundations.

If the blower is operating above this level then the installation must be fully evaluated to determine the source or cause of the vibration. And, the cause corrected.

In general, blower vibration levels should be monitored on a regular basis and the vibration trend observed for progressive or sudden change in level. If such a change occurs, the cause should be determined through spectral analysis.

## SAFETY PRECAUTIONS

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

- Blower casing and associated piping or accessories may become hot enough to cause major skin burns on contact.
- Internal and external rotating parts of the blower and driving equipment can produce serious physical injuries. Do not reach into any opening in the blower while it is operating, or while subject to accidental starting. Cover external moving parts with adequate guards.
- Disconnect power before doing any work, and avoid by-passing or rendering inoperative any safety or protective devices.
- If blower is operated with piping disconnected, place a strong coarse screen over the inlet and avoid standing in the discharge air stream.
- Stay clear of open inlet piping (suction area) of pressure blowers, and the open discharge blast from vacuum blowers.
- Stay clear of the blast from pressure relief valves and the suction area of vacuum relief valves.
- Avoid extended exposure in close proximity to machinery which exceeds safe noise levels.
- Use proper care and good procedures in handling, lifting, installing, operating and maintaining the equipment.
- Casing pressure must not exceed 25 PSI (172 kPa) gauge. Do not pressurize vented cavities from an external source nor restrict the vents.
- Do not use air blowers on explosive or hazardous gases.
- Other potential hazards to safety may also be associated with operation of this equipment. All personnel working in or passing through the area should be warned by signs and trained to exercise adequate general safety precautions.

A good program of inspection and maintenance servicing, followed consistently, is the most reliable method of minimizing repairs to a blower. A simple record of services and dates will help keep this work on a regular schedule. Basic service needs are lubrication, checking for hot spots or increase in vibration and noise and the recording of operating pressures and temperatures. Above all, a **blower must be operated within its specified rating limits**, to obtain satisfactory service life.

A newly installed blower should be checked frequently during the first month of full-time operation. Attention thereafter may be less frequent, depending on what the early checks have shown. Lubrication is normally the most important consideration. Unless operating conditions are unusually severe, a weekly check of oil levels in the gearbox, with addition of oil as required, should be sufficient. Complete oil changes should be made at intervals of 1000 operating hours, or more frequently if oil condition becomes poor.

Driver lubrication practices should be in accordance with the manufacturer's instructions. If direct connected to the blower through a lubricated type coupling, the coupling should be checked and greased each time blower oil is changed. This will help reduce wear and prevent it from causing vibration. In a belted drive system, check belt tension periodically and inspect for frayed or cracked belts. Refer to tensioning instructions under **INSTALLATION**.

In a new and properly installed blower there are no moving contacts between the two impellers, or between the impeller and cylinder or headplates. Wear is then confined to the bearing which support and locate the shafts, the shaft seals, and the timing gears. All are lubricated, and wear should be nominal if clean oil of the correct grade is always supplied. Seals are subject to deterioration as well as wear, and may require replacement at varying periods.

Shaft bearings have been selected to have optimum life under average conditions with proper lubrication. They are critical in the service life of the blower. Gradual bearing wear may allow a shaft position to change slightly, until rubbing develops between impeller and cylinder headplate. This will cause spot heating, which can be detected by feeling these surfaces. Sudden bearing failure is usually more serious. Since the shaft and impeller are no longer supported and properly located, extensive general damage to the blower casing and gears is likely to occur.

Shaft seals should be considered expendable items, to be replaced whenever drainage from the headplate vent cavity becomes excessive or when the blower is disassembled for any reason. Sealing effectiveness can vary considerably from seal to seal and is also affected by shaft smoothness under the seal lip. Because of these normal variables, minor seal leakage should not be considered an indicator for seal replacement.

Timing gear wear, when correct lubrication is maintained should be negligible over a period of years. Gear teeth are cut to provide the correct amount of backlash,

and gears correctly mounted on the shafts will accommodate a normal amount of tooth wear without permitting contact between lobes of the two impellers.

However, a high oil level will cause churning and excessive heating, indicated by an unusually high temperature at the bottom of the gear housing. Consequent heating of the gears will result in loss of tooth-clearance or backlash, and rapid wear of the gear teeth usually will develop. Continuation of this tooth wear will eventually produce impeller contacts (knocking), and from this point serious damage will be unavoidable if blower operation is continued. A similar situation can be produced suddenly by gear tooth fracture, which is usually brought on by sustained overloading or momentary shock loads.

Operating problems may also develop from causes other than internal parts failure. Operating clearances within a blower are only a few thousandths of an inch (hundredths of a mm). This makes it possible for impeller interferences or casing rubs to result from shifts in the blower mounting or from changes in piping support. Foreign materials sucked into the blower will also cause trouble, which can only be cured by disconnecting the piping and thoroughly cleaning the blower interior.

If this type of trouble is experienced, and the blower is found to be clean, try removing mounting strains. Loosen blower mounting bolts and reset the leveling and drive alignment. Then tighten mounting again, and make sure that all piping meets blower connections accurately and squarely before reconnecting it.

A wide range of causes for operating troubles are covered in the **TROUBLE SHOOTING CHECKLIST**. The remedies suggested there in some cases need to be performed by qualified mechanics with a good background of general experience, using procedures detailed in this manual. Major repairs generally are to be considered beyond the scope of maintenance, and should be referred to the nearest Sales Office listed on the last page.

Warranty failures should not be repaired at all, unless specific approval has been obtained through a Sales Office or the factory before starting work. Unauthorized disassembly within the warranty period may void the warranty.

When a blower 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 downtime. Under favorable conditions, protection will probably not be needed if shut down is not longer than a month. Under atmospheric conditions producing rapid corrosion, the blower should be protected immediately. If blower is to be shut down for an extended period of time, see suggestions for corrosion protection under installation.

It is recommended that major repairs, if needed, be performed at a Factory authorized service facility. However, it is recognized that this may not always be practical, especially when a spare blower is not available. If a blower is out of the warranty period, mechanical adjustments and parts replacement may be undertaken locally at the owner's option and risk. It is recommended that Factory Parts be used to insure fit and suitability. The maintenance of a small stock of on-hand spare parts can eliminate possible

delays. When ordering parts give Item Numbers and their word descriptions from Figures 11 & 13. Also specify quantities wanted and the blower size and serial number from the nameplate.

Repairs or adjustments are best performed by personnel with good mechanical experience and the ability to follow the instructions in this manual. Some operations involve extra care and patience, and a degree of precision work. This is especially true in timing impellers and in handling bearings. Experience indicates that a high percentage of bearing failure is caused by dirt contamination before or during assembly. Therefore, the work area should be cleaned before starting disassembly, and new or re-usable parts protected during progress of the work.

In the following outlines of repair procedures, numbers shown in brackets ( ) correspond to the Item Numbers used in assembly drawing, Figures 11 & 13. It is recommended that the procedure be studied carefully and completely, with frequent reference to the drawings, before starting work. This will produce better efficiency through an understanding of what work is to be done, and the order of doing it. Before disassembly, mark all parts so that they may be returned to original locations or relative positions.

#### A – Replacing Timing Gears

1. Drain all oil from the gearhouse by removing drain plug (21) in the bottom. Remove gearhouse by taking out all cap screws (23) in its flange. It may be necessary to bump the sides with a wood block or mallet to break the flange joint.
2. Reach through one of the blower pipe connections and place a chalk mark on the strip of one impeller and the mating waist of the other, so that they may easily be returned to their original relative positions.

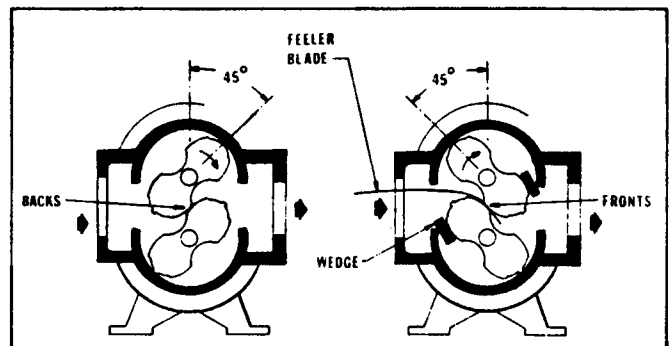


Figure 5- Impeller Timing Viewed From Gear End

3. **GEAR REMOVAL:** For this operation, the impellers should be wedged as shown in Figure 5. Back off gear clamping nuts (17) about 1/4". Use a puller of the type shown in Figure 10. Position it around the gear per Figure 9. As the puller set screw is torqued, the puller will have a tendency to turn and contact teeth of the other gear. To prevent this contact, hold the puller corner nut with a wrench while torquing the set screw. Once the gear is unseated, remove the puller. Remove gear nuts (17) and the gear. Repeat same procedure for the other gear. **NOTE:** Do not remove gear nuts (17) completely before the gears are unseated from the taper fits or damage/injury may result.

4. **GEAR INSTALLATION:** Place impellers in correct position as previously marked. Be sure shafts and gear bores are clean and free of scratches. Clean the shaft tapered fits. Place hardwood wedges as shown in Figure 5. Oil gear nut threads, face of the nut, and shaft threads. Install drive gear (4) and gear nut (17). Tighten the drive gear nut to the torque given in Table 5. Blower assembly must be fastened down for torquing operation.

Table 5 - GEAR NUT TORQUE

Gear Size (in.)	Torque	
	lb.-ft.	(kg-m)
2.5	60	(8.3)
3.5	110	(15.2)
4.0	190	(26.3)
5.0	250	(34.6)
6.0	400	(55.3)
7.0	550	(76.1)

5. Installing driven gear (4) – Insert a long, metal feeler gauge between the impellers' lobes at the fronts or backs as shown in Figure 5. Feeler gauge thickness to be a middle value from Table 6 for fronts and backs. Oil gear nut threads, face of the nut, and shaft threads. Install driven gear and gear nut. Tighten lightly with a small wrench, then check front and back clearances against Table 6 for each 45° position. Both fronts and backs should be about the same and within the specified range in Table 6. Adjust gear position, if necessary, then insert the corrected feeler gauge and wedges and use a torque wrench to tighten the gear nut to the torque specified in Table 5. Remove wedges and rotate the drive shaft by hand to make sure there are no gear tight spots or impeller contacts.

**Caution! Keep fingers away from impellers and gears.**

6. Check the end clearances between impellers and headplates. Adjust clearances per B-15 below.
7. When clearances are correct, clean and re-install the gearhouse. Check condition of flange gasket (7) and replace if questionable. Fill gearhouse to correct level with proper grade of oil.

#### B – Replacing Shaft Bearings, and Impellers

Remove coupling or sheave from the drive shaft. Drain and remove gearhouse, and pull the timing gears. If gears are to be re-used, mark them so they may be returned to the same shafts.

1. Break corners and deburr the keyway. Remove bearing end cover at the drive end. Remove bearing clamp plates (34).

2. Make single and double identifying punch marks on the mating edges of headplate and cylinder flanges at the two ends of the blower.
3. At the drive end, drive out the two dowel pins and remove all cap screws holding headplate to cylinder. By inserting jacking screws into the two threaded flange holes, and turning them in evenly, the headplate will be separated from the cylinder. As the headplate comes off the shafts it will bring bearings with it. 2-1/2" gear diameter units do not have tapped holes for jack screws in the drive end headplates. Remove dowel pins and all cap screws holding headplate to cylinder and foot on the drive end. Support unit under gear end cylinder flange with the shafts vertical. Using soft metal block against gear end shafts, push them out of gear end headplate.

4. For 2-1/2" gear diameter units, support the drive end headplate on the underside, and using soft metal block against drive end, shafts, push them out of drive end headplate.

For 3-1/2", 4", 6" & 7" gear diameter units, from the gear end, using a wood or soft metal block against the ends of the shafts, drive them out of the headplate. If they are to be reused, protect them from damage in this operation.

5. If blower interior surfaces need cleaning, it may be advisable to separate the gear end headplate from the cylinder. Use the same general procedure as employed at the drive end.
6. Working from the back (flat) face of each headplate, push or tap out the bearings and seals. Use a round bar or tube that will pass through the shaft clearance holes in the headplates. All lip seals will be damaged during removal and must be replaced.
7. Clean bearing and seal pockets in headplates and remove burrs or rough edges. (Apply a thin coating of sealant on seal O.D.) Press new seals (27) into gear end headplate using a round tube or bar with recessed end that will bear on the outer metal edge of seal enclosure. Seal lip should point toward the driving tool. Seals to be flush with outboard bore face. Apply a light coat of oil or grease to the seal lips. In a similar fashion, install lip seals into the drive end headplate.

8. Place cylinder on a flat surface. Assemble gear end headplate to cylinder after checking flange punch marks. Drive in the two locating dowel pins before tightening flange screws. Also install gear end foot using the same longer cap screws (32) and washers (41). (On 6" & 7" UNIVERSAL RAI® install both gear and feet.)

9. Place the assembly horizontally on steel blocks with gear end headplate on bottom. The height of the blocks should be sufficient to clear gear end shaft extensions. Assemble impellers into the cylinder with the drive

- shaft (longer shaft) in same location as in original assembly. Before starting the shafts through the headplate holes, make sure shaft ends have no sharp or rough edges to damage seal lips. Position impellers at 90° to each other in the cylinder, using lobe-and-waist match marks if original impellers are being re-installed. Install drive end headplate and feet in same manner as gear end.
10. It is recommended that new bearings be used for rebuild. Apply thin film of machine oil on the shaft bearing fit, bearing I.D., and headplate bearing bore. Install drive end bearings into headplate. Use a tube with flanged end that will contact both bearing faces simultaneously. Refer to Figure 11 for proper bearing depths. NOTE: Cylindrical drive bearing should be installed with inner race large shoulder facing outboard.
  11. Place blower on its feet on a flat surface. Loosen feet cap screws (32) and square up unit. Re-tighten cap screws (32). Clamp unit down to a solid base for further assembly.
  12. Oil the gear end bearing fits as described previously. Install 2-1/2-5" UNIVERSAL RAI® gear end bearings flush with the headplate bearing shoulders using proper drivers. On 6" & 7" UNIVERSAL RAI®, install thrust washer (29) in bearing bores then install gear end bearings so that they protrude 1/16" (1.6mm) above headplate surface.
  13. Install bearing clamp plates (34). On 6" & 7" UNIVERSAL RAI®, impeller end clearances are also to be set during this step. Install clamp plates (34) with cap screws (31) making sure that the gap between the clamp plates and the headplate is even all around, at the same time, set end clearances per Table 5.
  14. Install gears and time impellers as in (A).
  15. For setting end clearances on 2-1/2-5" gear diameter units, special tools, thrust adjuster fork Figure 7 and thrust adjuster saddle Figure 8 are required. Refer to Figure 6 for installation of tools. The flat side of the saddle rests against the bearing inner race and the flat side of the fork rests against the back side of the gear. Install a shim, with thickness equal to gear clearance (Table 6), between the impeller and the gear end headplates. Tap on top of the fork until the shim becomes snug. Remove the shim and check end clearances. To increase gear end clearance, tap on the end of the gear end shaft with a soft metal mallet. On units, UNIVERSAL RAI®, set end clearances for 6" & 7" by turning cap screws (31) evenly in or out.
  16. Install drive end cover (5) after packing bearing cavities with suitable grease. Replace drive shaft seal. Lip must point toward (33) the bearing. Exercise care not to damage the lip as it passes over shaft keyway.
  17. Install gasket item (7). Install the gear house after cleaning out the inside. Tighten gear box cap screws (23) evenly. Fill with correct grade of oil until oil flows out through oil level hole. Grease drive and bearings. (See Lubrication.)
  18. Reinstall coupling or belt sheave making sure that they have a slight slide fit with the shaft and could be installed by hand.

Where repairs involve parts replacement, it is recommended that Factory Parts be used to insure fit and suitability. Delay in making such repairs can be reduced by having spare parts on hand.

When ordering parts, please furnish all information from the blower nameplate.

Repairs or adjustments to blowers should be performed by personnel with a good background of general mechanical experience and the ability to follow the detailed instructions in this manual. No special tools are required. Some operations involve extra care and a degree of precision work. This is especially true in timing impellers, and in handling bearings. Experience indicates that a high percentage of bearing failures is caused by dirt contamination before or during assembly. Therefore, clean the work area before starting disassembly, and protect new or reusable parts during progress of the work. (See page 25 for Repair Kit Information.)

## INTERNAL CLEARANCES

References to operating clearances in this manual include only one mention of the specific amount of clearance to be used or expected. For units in good condition this information is not essential in field service work. Situations may arise, however, when it is desirable to compare existing clearances with the correct Engineering values or to re-establish clearances.

Listed in Table 6 are the ranges of impeller clearances used in factory assembly of normal UNIVERSAL RAI® blowers. It should be kept in mind that clearances may change slightly in service, but should never be less than the minimum values listed. Only well qualified personnel should attempt to measure clearances for direct comparison with this data.

Table 6 – Normal Clearances for UNIVERSAL U-RAI® and U-RAI-J™ Blowers – Inches (MM)

SIZE	IMPELLER ENDS			CYLINDER		IMPELLER
	TOTAL	DRIVE END MINIMUM	GEAR END MINIMUM	INLET & DISCHARGE	CENTER	FRONTS BACKS
22	.006/.010 (.15-.25)	.003 (.08)	.003 (.08)	.004/.005 (.10-.13)	.002/.003 (.05-.08)	.007/.01 (.18-.25)
24	.006/.010 (.15-.25)	.003 (.08)	.003 (.08)	.004/.005 (.10-.13)	.002/.003 (.05-.08)	.007/.01 (.18-.25)
32	.006/.011 (.15-.28)	.003 (.08)	.003 (.08)	.004/.006 (.10-.15)	.002/.003 (.05-.08)	.01/.012 (.25-.30)
33/33J	.006/.011 (.15-.28)	.003 (.08)	.003 (.08)	.004/.006 (.10-.15)	.002/.003 (.05-.08)	.01/.012 (.25-.30)
36/36J	.006/.011 (.15-.28)	.003 (.08)	.003 (.08)	.004/.006 (.10-.15)	.002/.003 (.05-.08)	.01/.012 (.25-.30)
42	.008/.011 (.20-.28)	.004 (.10)	.004 (.10)	.005/.007 (.13-.18)	.003/.004 (.08-.10)	.009/.012 (.23-.30)
45/45J	.008/.013 (.20-.33)	.004 (.10)	.004 (.10)	.005/.007 (.13-.18)	.003/.004 (.08-.10)	.012/.015 (.30-.38)
47/47J	.008/.013 (.20-.33)	.004 (.10)	.004 (.10)	.005/.007 (.13-.18)	.003/.004 (.08-.10)	.012/.015 (.30-.38)
53	.008/.011 (.20-.28)	.004 (.10)	.004 (.10)	.005/.008 (.13-.20)	.003/.004 (.08-.10)	.011/.013 (.28-.33)
56/56J	.008/.013 (.20-.33)	.004 (.10)	.004 (.10)	.005/.008 (.13-.20)	.003/.004 (.08-.10)	.015/.017 (.38-.43)
59	.008/.013 (.20-.33)	.004 (.10)	.004 (.10)	.005/.008 (.13-.20)	.003/.004 (.08-.10)	.015/.017 (.38-.43)
65	.012/.016 (.30-.40)	.008 (.20)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.010/.014 (.25-.36)
68	.014/.018 (.36-.46)	.010 (.25)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.010/.014 (.25-.36)
615	.014/.018 (.36-.46)	.010 (.25)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.010/.014 (.25-.36)
76	.012/.016 (.30-.40)	.008 (.13)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.013/.015 (.33-.38)
711	.014/.018 (.36-.46)	.010 (.25)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.013/.015 (.33-.38)
718	.014/.018 (.36-.46)	.010 (.25)	.004 (.10)	.006/.008 (.15-.20)	.006/.008 (.15-.20)	.013/.015 (.33-.38)

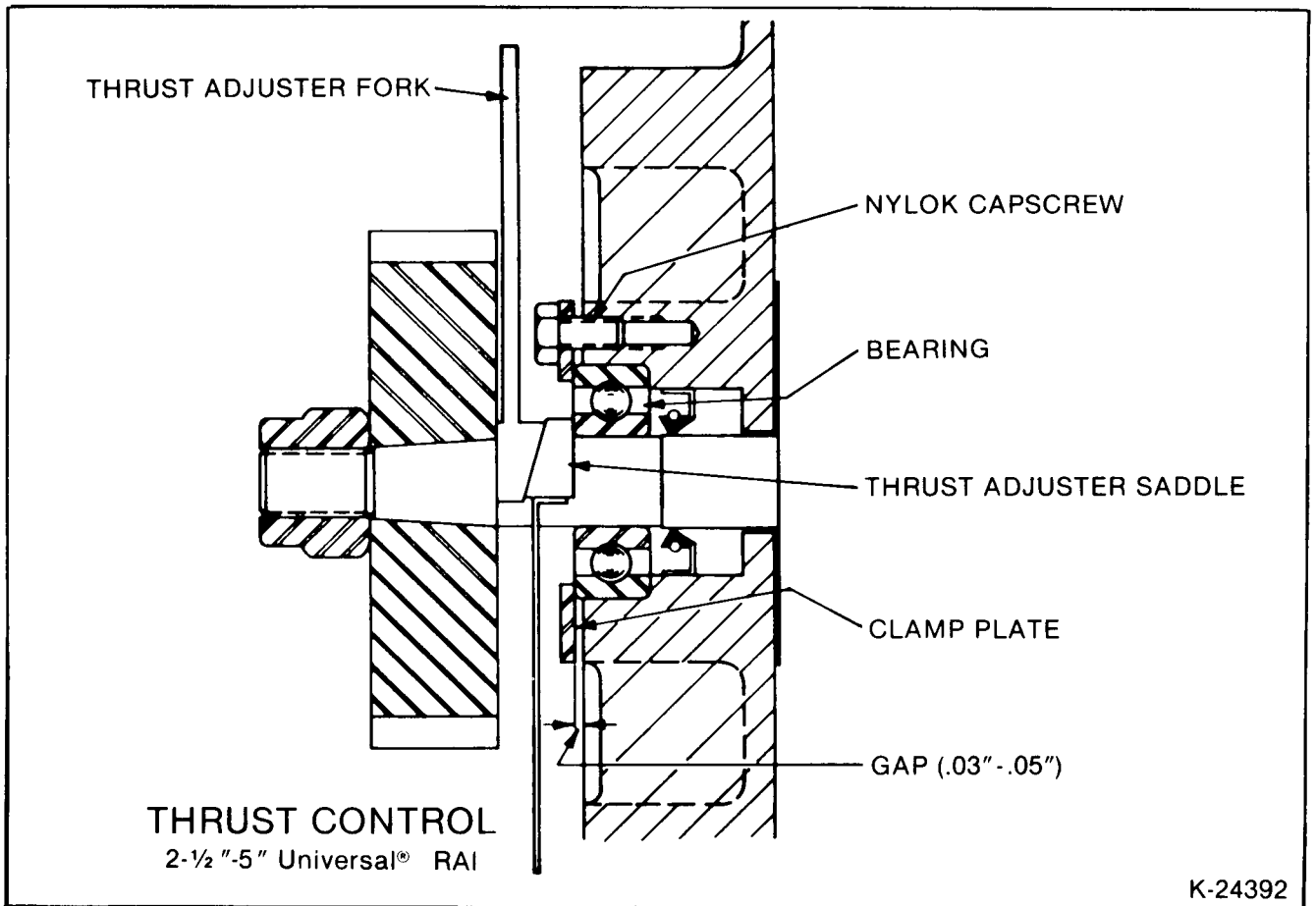
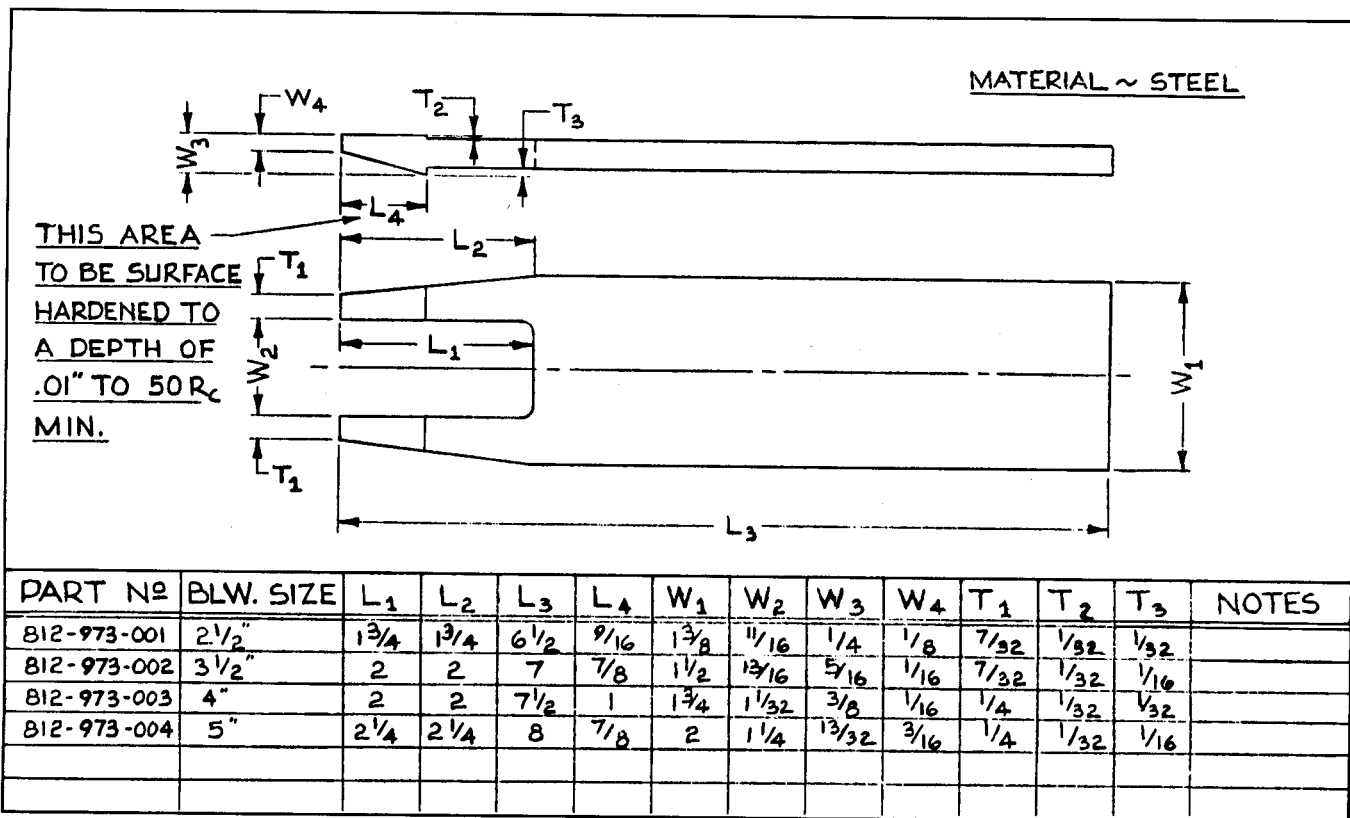


Figure 6 – Thrust Setting, 2 1/2"-5" UNIVERSAL RAI®



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Figure 7 - Thrust Adjuster Fork

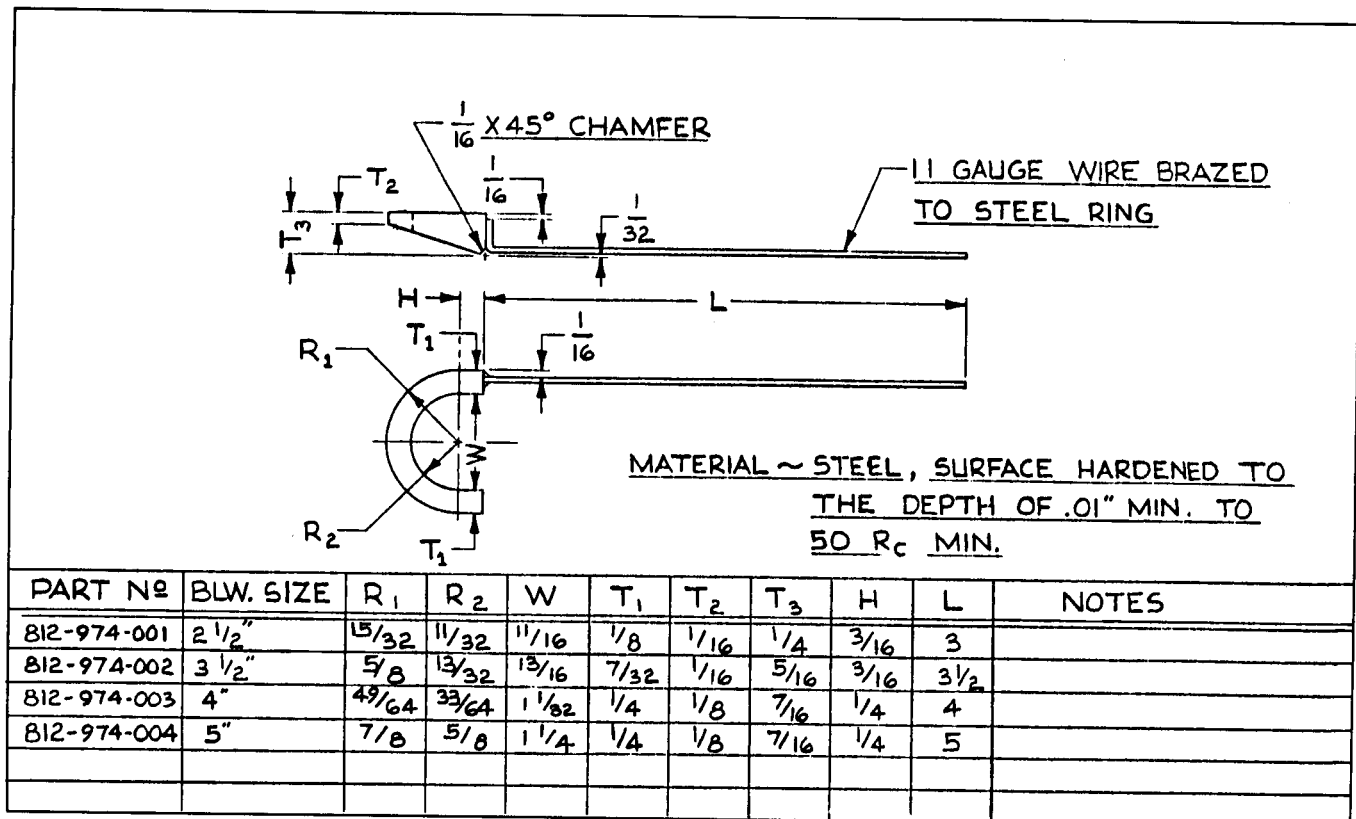


Figure 8 - Thrust Adjuster Saddle

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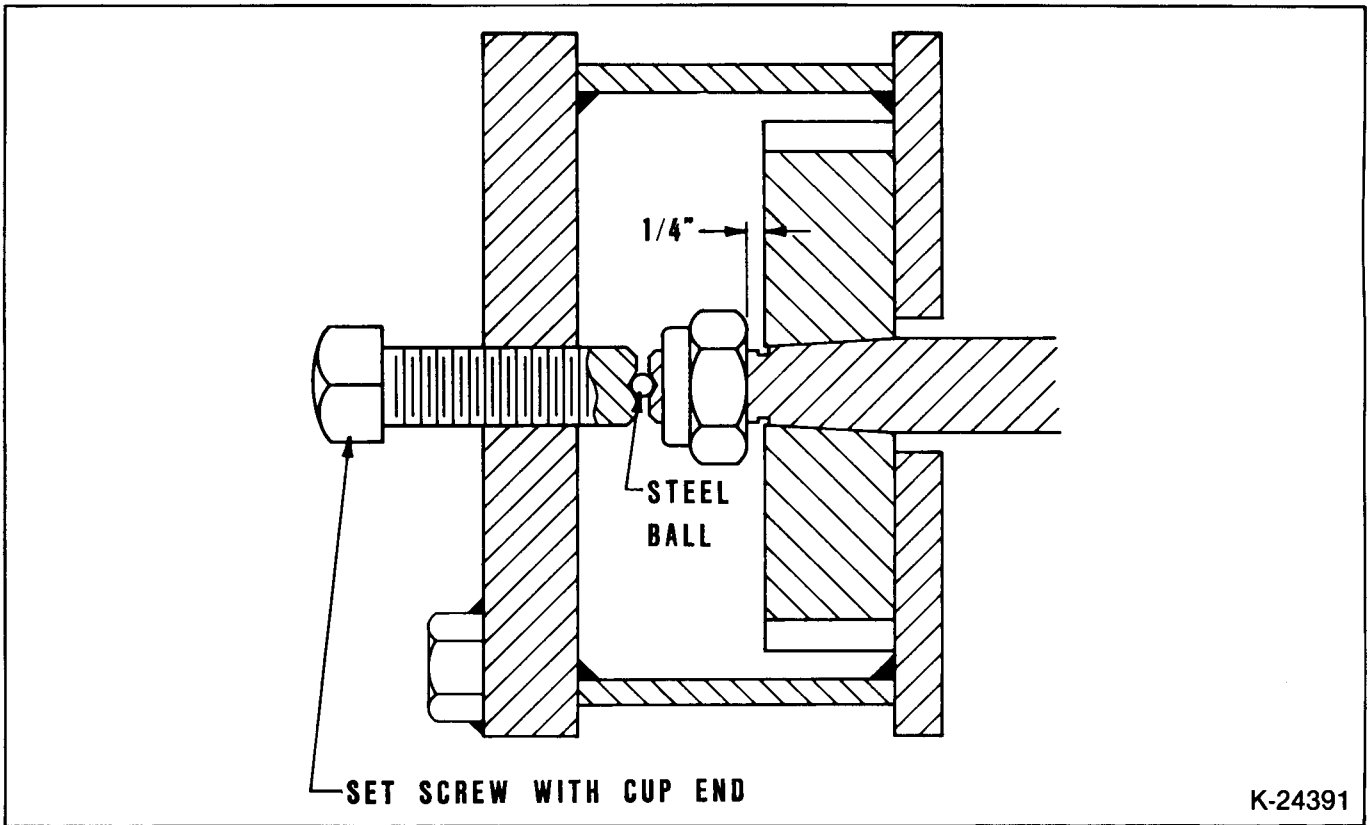
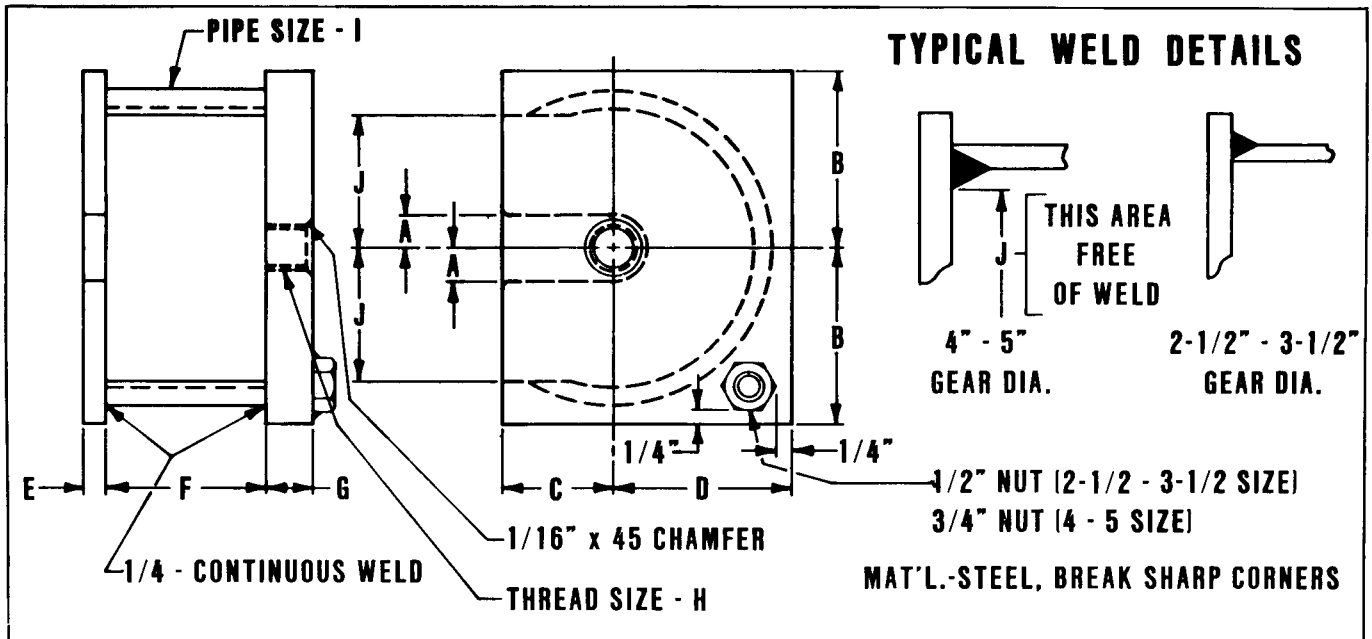


Figure 9 - Gear Removal

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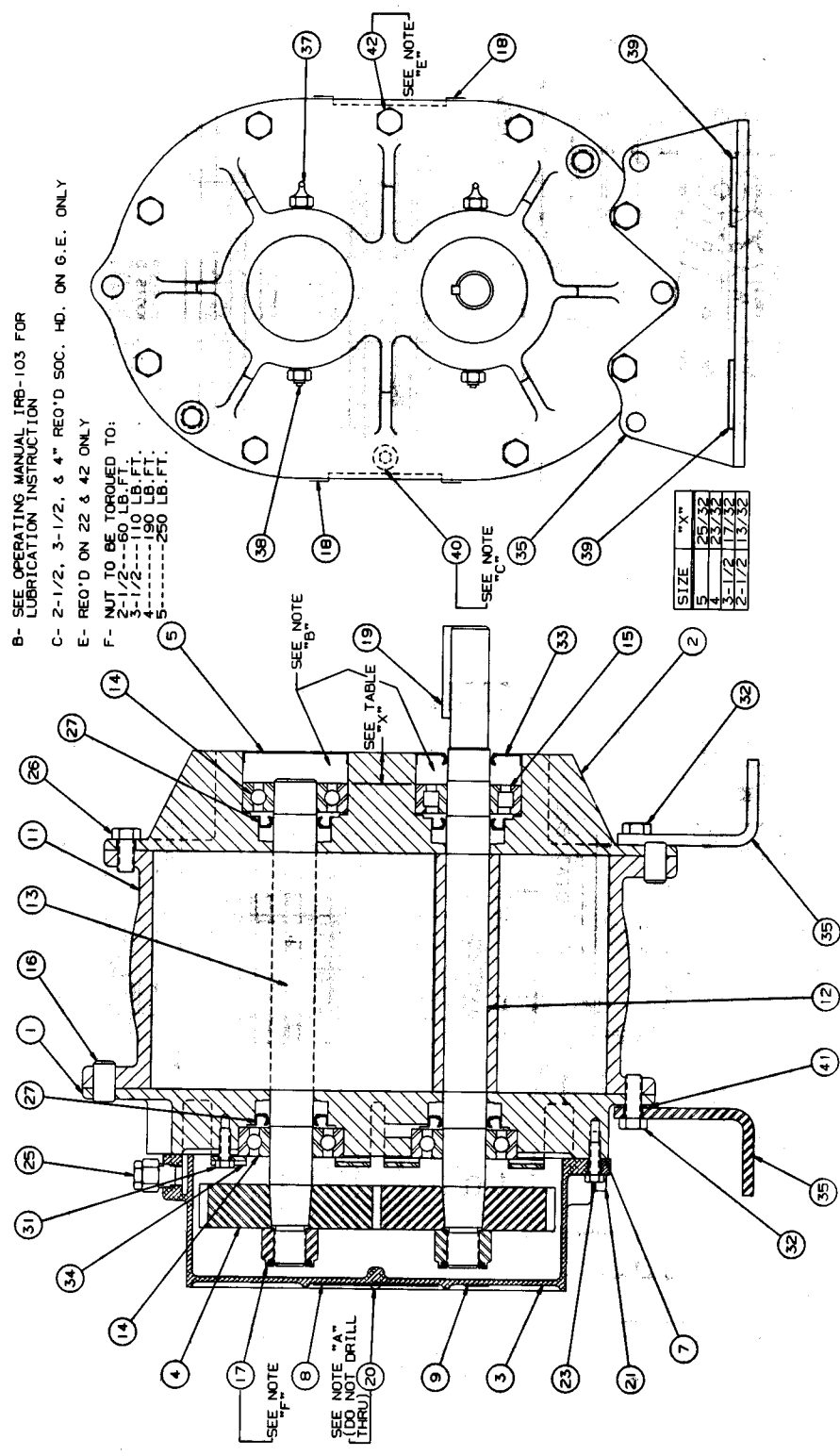
BLOWER SIZE	PART NO.	A	B	C	D	E	F	G	H	I	J
2-1/2	812-977-001	3/8	2	1-1/16	2	1/4	2	5/8	7/16-14	3" SCH. - 40	1-3/8
3-1/2	812-977-002	7/16	2-1/2	1-1/4	2-1/2	5/16	2-3/8	3/4	1/2-13	4" SCH. - 40	1-7/8
4	812-977-003	17/32	2-13/16	1-3/4	2-13/16	3/8	2-1/2	3/4	5/8-11	5" SCH. - 40	2-1/8
5	812-977-004	5/8	3-3/8	2	3-3/8	7/16	3	1	3/4-10	6" SCH. - 40	2-11/16

Figure 10 - Gear Pullers for UNIVERSAL RAI® with Tapered Gear Bores

812-977



- NOTES:
- A- #25 (.150) DRILL 1/4 DP & INSTALL ITEM #20 (SCREWS) IN ASSEMBLY
  - B- SEE OPERATING MANUAL IRB-103 FOR LUBRICATION INSTRUCTION
  - C- 2-1/2, 3-1/2, & 4" REQ'D SOC. HD. ON G.E. ONLY
  - E- REQ'D ON 22 & 42 ONLY
  - F- NUT TO BE TORQUED TO:  
 2-1/2---60 LB.FT.  
 3-1/2---110 LB.FT.  
 4---150 LB.FT.  
 5---250 LB.FT.



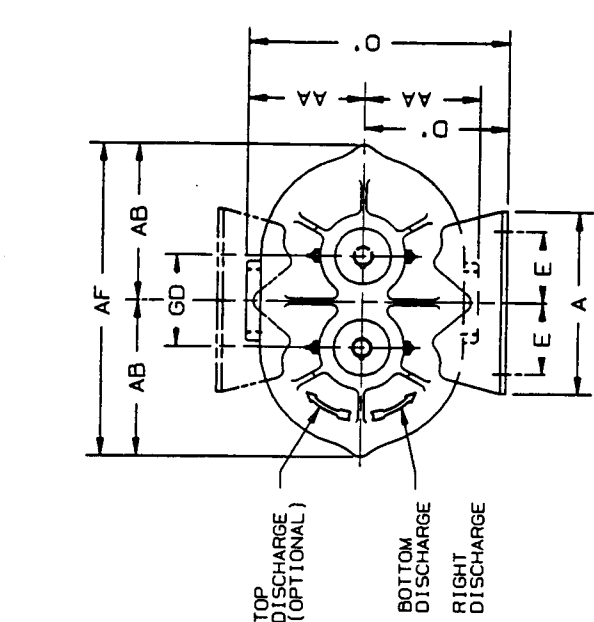
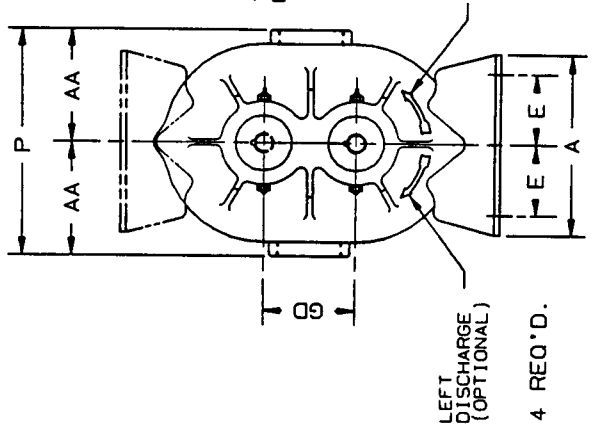
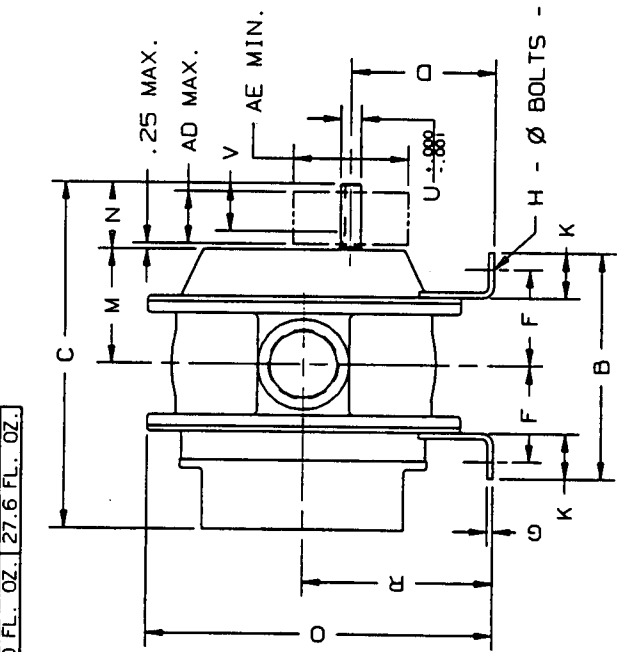
ITEM	PART NAME	ITEM	PART NAME	ITEM	PART NAME	ITEM	PART NAME
1	Headplate Gear End	12	Impeller & Shaft-Drive	21	Plug, Pipe	35	Foot
2	Headplate Drive End	13	Impeller & Shaft-Driven	23	Screw, Hex	37	Fitting, Grease
3	Gearbox	14	Bearing G.E., -Driven	25	Breather	38	Fitting, Relief
4	Gears	15	Bearing D.E., -Drive	26	Screw, Hex	7	Gasket
5	Cover-Blind	16	Pin, Dowel	27	Seal, Lip	39	Washer Flat
8	Nameplate-Serial Number	17	Gear Nut	31	Screw, Hex	40	Screw Socket
9	Nameplate-Lub	18	Plug Tin	32	Screw, Hex	41	Washer
		19	Key	33	Seal Lip-Drive	42	Screw Hex
11	Cylinder	20	Screw, Self Tap	34	Clamp Plate		

Figure 11 - Assembly of UNIVERSAL RAI® blowers, 2 1/2" -5" Gear Diameter

864-720-023



FRAME	APPROX. OIL CAPACITY
3-1/2	8.5 FL. OZ.
4	12.7 FL. OZ.
5	16.0 FL. OZ.



# UNIVERSAL RAI-J WHISPAIR BLOWER

W - INLET & DISCHARGE  
 AD - SHEAVE WIDTH  
 AE - SHEAVE DIAMETER

FRAME SIZE	GD	A	B	C	D	D'	E	E	F	F	G	H	K	M	N	O	O'	P	R	U	KEYWAY	W	V	AA	AB	AD	AE	AF	APPROX. WT. LBS
33	3.50	7.25	7.63	12.13	5.00	2.50	2.88	3.00	3.25	.25	.44	1.75	3.81	2.44	12.81	10.00	0.00	6.75	.750	.188x.094	2"	1.63	5.00	5.06	1.91	5.00	12.13	84	
36																					2-1/2	1.75	5.50					112	
45	4.00	8.00	10.00	15.50	6.25	3.00	3.13	3.56	4.25	.31	.44	2.00	5.06	2.94	15.06	12.25	2.00	8.25	.875	.188x.094	2-1/2	2.13	6.00	6.81	2.31	5.00	13.63	119	
47																					3"	2.50	6.00					136	
56	5.00	10.50	11.00	18.00	6.25	6.75	3.50	4.25	5.00	.25	.50	1.88	5.81	3.38	17.38	14.00	14.50	8.75	.125	.25x.125	4"	2.50	7.25	8.63	3.06	6.00	17.25	180	

ALL DIMENSIONS IN INCHES

CERTIFIED CORRECT FOR

CUSTOMER ORDER No. \_\_\_\_\_

ROOTS ORDER No. \_\_\_\_\_

DATE \_\_\_\_\_

V-BELT DRIVE DATA

BELTS \_\_\_\_\_

DRIVE SHEAVE \_\_\_\_\_

DRIVEN SHEAVE \_\_\_\_\_

CENTER DISTANCE \_\_\_\_\_

REVISONS \_\_\_\_\_

DR 9-25-92

CHKD

APP

873-959-021

DRESSER INDUSTRIES, INC.  
 ROOTS DIVISION  
 900 WEST MOUNT STREET  
 CONNERSVILLE, INDIANA 47331

Figure 12A - Dimensional Assembly of UNIVERSAL RAI-J™ blower (2-1/2"-5")

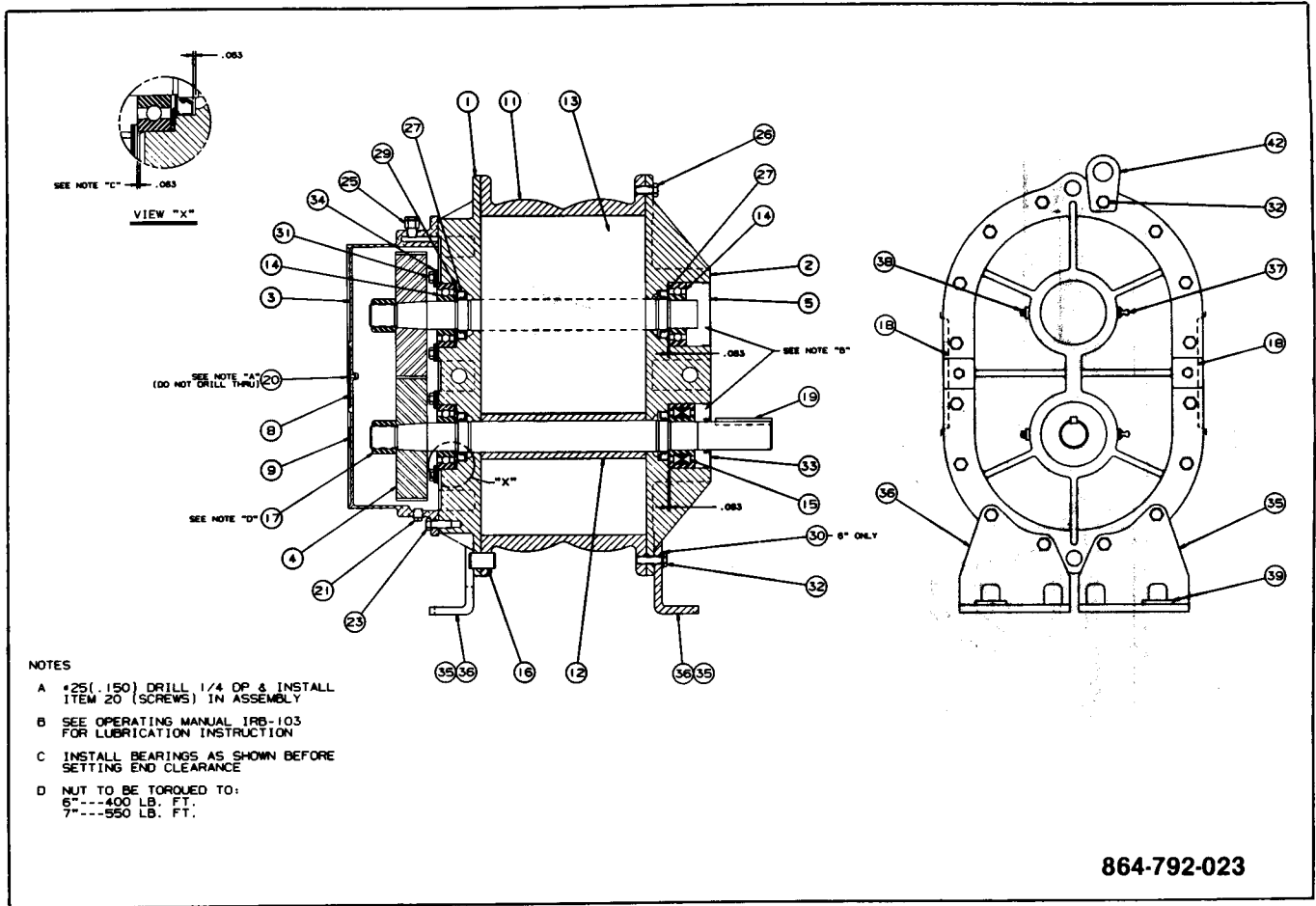
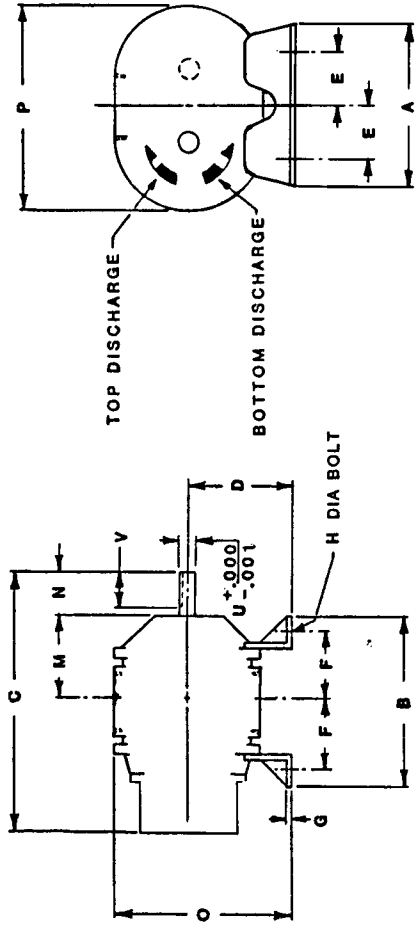


Figure 13 - Assembly of UNIVERSAL RAI® blowers, 6" and 7" Gear Diameter

PARTS LIST FOR 6"-7" UNIVERSAL RAI®

ITEM	PART NAME	ITEM	PART NAME	ITEM	PART NAME	ITEM	PART NAME
1	Headplate - G.E.	13	Imp & Shaft - Drvn	25	Plug - Vent	36	Foot - Lt. Hand
2	Headplate _ D.E.	14	Bearing, Ball	26	Screw, Cap - Hex	37	Fitting, Grease
3	Gearbox	15	Bearing, Roller	27	Seal, Lip	38	Plug - Vent
4	Gear Assembly	16	Pin, Dowel	29	Washer - Wavy Spr.	39	Washer - Oblong
5	Plug - Opening	17	Nut, Stop - Hex	30	Washer	40	Pipe - Tbe. (Close)
7	Gasket, Gearbox	18	Plug - Opening	31	Screw, Cap - Hex	41	Coupling - Pipe
8	Nameplate - S/N	19	Key, Square	32	Screw, Cap - Hex	42	Lifting Lug
9	Namplate - Lube	20	Screw, Rd. Hd.	33	Seal, Lip		
11	Cylinder	21	Plug, Pipe - Sq. Hd.	34	Brg. Clamp Plate		
12	Imp & Shaft - Drive	23	Screw, Cap - Hex	35	Foot - Rt. Hand		





NOTE:  
UNIVERSAL RAI

- 45 & 56 U-RAI WILL HAVE TO RUN AT REDUCED SPEED TO DUPLICATE AF PERFORMANCE.
  - LARGER STANDARD SHAFT THAN AF. SEE DIMENSION "U".
  - U-RAI INLET & OUTLET CONNECTIONS ARE LARGER THAN AF ON THE FOLLOWING SIZES: 24, 45, 47, 56 & 59. SEE DIMENSION "W".
  - 45 U-RAI REPLACES 44 AF.
  - 56 U-RAI REPLACES 55 AF.
- FOR ADDITIONAL INFORMATION CONTACT YOUR SALES REPRESENTATIVE OR THE FACTORY.

W-INLET & DISCHARGE  
ALL DIMENSIONS IN INCHES  
DIMENSIONS NOT CERTIFIED FOR CONSTRUCTION

FRAME SIZE	A	B	C	D	E	F	H	M	N	O	P	U	V	KEYWAY	W
22 U-RAI	5.13	5.00	9.75	3.75	2.00	2.00	3/8	2.63	2.50	6.08	9.25	.625	1.81	3/16 x 3/32	1" NPT
22 AF	5.50	5.06	9.13	3.75	2.00	2.00	3/8	2.63	1.94	6.88	9.25	.5875	1.31	3/16 x 3/32	1" NPT
24 U-RAI	5.13	7.00	11.75	3.75	2.00	3.00	3/8	3.63	2.50	6.88	9.25	.625	1.81	3/16 x 3/32	2" NPT
24 AF	5.50	7.06	11.13	3.75	2.00	3.00	3/8	3.63	1.94	6.88	9.25	.5875	1.31	3/16 x 3/32	1-1/2" NPT
33 U-RAI	7.25	7.63	12.13	5.00	2.88	3.00	3/8	3.81	2.44	8.88	12.13	.750	1.63	3/16 x 3/32	2" NPT
33 AF	7.25	7.44	12.56	5.00	2.88	3.00	3/8	3.81	2.63	8.88	12.13	.6562	1.56	3/16 x 3/32	2" NPT
36 U-RAI	7.25	10.00	14.63	5.00	2.88	4.18	3/8	5.00	2.56	8.88	12.13	.750	1.75	3/16 x 3/32	2-1/2" NPT
36 AF	7.25	9.81	14.94	5.00	2.88	4.18	3/8	5.00	2.63	8.88	12.13	.6562	1.88	3/16 x 3/32	2-1/2" NPT
42 U-RAI	8.00	7.25	13.00	6.25	3.13	2.94	3/8	3.68	3.16	10.63	13.63	.875	2.31	3/16 x 3/32	1-1/2" NPT
42 AF	8.25	7.13	12.88	6.25	3.13	2.94	3/8	3.68	3.00	10.63	13.63	.7812	2.38	3/16 x 3/32	1-1/2" NPT
45 U-RAI	8.00	10.00	15.50	6.25	3.13	3.56	3/8	5.06	2.94	10.63	13.63	.875	2.13	3/16 x 3/32	2-1/2" NPT
44 AF	8.25	8.83	14.13	6.25	3.13	3.56	3/8	4.31	3.00	10.63	13.63	.7812	2.38	3/16 x 3/32	2" NPT
47 U-RAI	8.00	11.75	17.63	6.25	3.13	5.18	3/8	5.94	3.31	10.50	13.63	.875	2.50	3/16 x 3/32	3" NPT
47 AF	8.25	11.63	17.38	6.25	3.13	5.18	3/8	5.94	3.00	10.63	13.63	.7812	2.30	3/16 x 3/32	2-1/2" NPT
53 U-RAI	10.50	8.38	15.38	6.75	4.25	3.69	3/8	4.50	3.66	11.88	17.25	1.125	2.75	1/4 x 1/8	2-1/2" NPT
53 AF	10.75	8.81	15.44	5.75	4.25	3.69	3/8	4.50	3.63	12.00	17.25	.9687	2.88	1/4 x 1/8	2-1/2" NPT
56 U-RAI	10.50	11.00	18.00	6.75	4.25	4.25	3/8	5.81	3.38	12.25	17.25	1.125	2.50	1/4 x 1/8	4" NPT
55 AF	10.75	9.81	16.56	6.75	4.25	4.25	3/8	5.06	3.63	12.00	17.25	.9687	2.88	1/4 x 1/8	2-1/2" NPT
59 U-RAI	10.50	14.00	21.18	6.75	4.25	6.50	3/8	7.31	3.38	12.25	17.25	1.125	3.00	1/4 x 1/8	4" NPT
59 AF	10.75	14.31	21.06	6.75	4.25	6.50	3/8	7.31	3.63	12.00	17.25	.9687	2.88	1/4 x 1/8	3" NPT

**COMPARING ROOTS UNIVERSAL RAI® TO ROOTS AF**

DRESSER INDUSTRIES, INC.  
ROOTS OPERATIONS  
900 WEST MOUNT STREET,  
CONNERSVILLE, INDIANA 47331

**DRESSER** **DMD ROOTS**

DB 1-7-86  
863-813-021

Figure 15 - Comparing ROOTS™ UNIVERSAL RAI® to ROOTS™ AF

Major Changes when Replacing AF with UNIVERSAL RAI® blower

Size & Type	Sheave Bushing Dia.	Inlet Size	Disch. Size	Mounting Feet
22 UNIVERSAL RAI® 22 AF	.625" .5875"	1" 1"	1" 1"	Interchangeable
24 UNIVERSAL RAI® 24 AF	.625" .5875"	2" 1-1/2"	2" 1-1/2"	Interchangeable
32 UNIVERSAL RAI® 315 AF	.750" .6562"	1-1/4" 3/4"	1-1/4" 3/4"	Special Feet
33 UNIVERSAL RAI® 33 AF	.750" .6562"	2" 2"	2" 2"	Interchangeable
36 UNIVERSAL RAI® 36 AF	.750" .6562"	2-1/2" 2-1/2"	2-1/2" 2-1/2"	Interchangeable
42 UNIVERSAL RAI® 42 AF	.875" .7812"	1-1/2" 1-1/2"	1-1/2" 1-1/2"	Interchangeable
45 UNIVERSAL RAI® 44 AF	.875" .7812"	2-1/2" 2"	2-1/2" 2"	Reverse Feet
47 UNIVERSAL RAI® 47 AF	.875" .7812"	3" 2-1/2"	3" 2-1/2"	Interchangeable
53 UNIVERSAL RAI® 53 AF	1.250" .9687"	2-1/2" 2-1/2"	2-1/2" 2-1/2"	Special Feet
56 UNIVERSAL RAI® 55 AF	1.250" .9687"	4" 2-1/2"	4" 2-1/2"	Special Feet
59 UNIVERSAL RAI® 59 AF	1.250" .9687"	4" 3"	4" 3"	Special Feet

\*To maintain AF performance with UNIVERSAL RAI®, the blower speed will have to be reduced by sheave change. See Figure 15 drawing for your specific blower size.

**CAUTION CAUTION CAUTION**

**MAKE CERTAIN THAT THE BREATHER IS LOCATED ON TOP AND THE DRAIN PLUG IN THE BOTTOM OF THE GEAR BOX.**

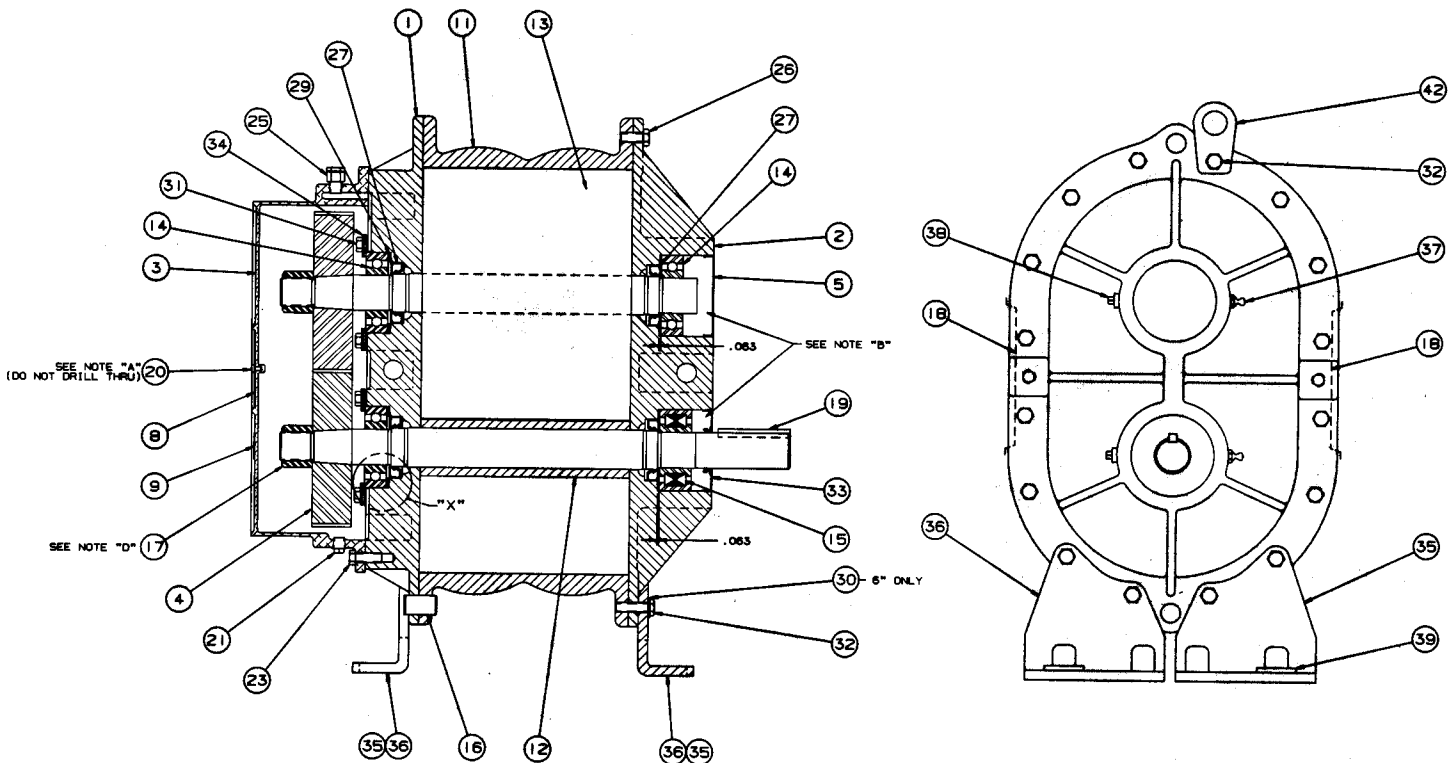
***Roots Products are sold subject to the  
current General Terms of Sale, GTS-5001  
as modified by the 18 months  
Uncontested Warranty Policy and  
Procedure, WP-5020.***



## REPAIR KIT INFORMATION

UNIVERSAL RAI®				
REF. NO.	QTY.	PART DESCRIPTION	REPAIR KIT PART NOS.	
4	1 Pr.	Timing Gear	FRAME SIZE	REPAIR KIT NO.
5	1	Plug - Opening	2"	65-101-ORK
7	1	Gasket	3"	65-104-ORK
14	1	Bearing, D.E. - DRVN	4"	65-107-ORK
14	2	Bearing, G.E.	5"	65-111-ORK
15	1	Bearing, Dr. Shaft	*6"	65-115-ORK
17	1	Gear Nut	*7"	65-119-ORK
27	2	Seals, D.E.		
27	2	Seals, G.E.		
31	4	Capscrew - Selflock		
33	1	Seal - Dr. Shaft		

\*Repair kits for the 6" and 7" UNIVERSAL RAI® do not contain gears.



**For Prices & Availability Contact:**  
**POWER EQUIPMENT COMPANY**  
 2011 Williamsburg Road  
 Richmond, VA 23231  
[www.peconet.com](http://www.peconet.com)