

**ROOTS****DRESSER**

# RAI

## INSTRUCTIONS ROTARY LOBE BLOWERS

3½ - 8 inch gear diameter

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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 nearest Sales Office. See list on last page.
- 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 event of trouble during installation or operation, do not attempt repairs of Roots furnished equipment. Notify nearest Sales Office, 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.

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.

Roots Type 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 RAI blowers. These limits apply to all blowers of normal construction, having operating clearances as listed in Tables 5 and 6 when operated under standard atmospheric conditions. **Do not exceed any of these limits.**

**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 (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 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.) 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 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, except that frames 44, 47, 55 and 59 are limited to 160°F.
- D. On frames 44, 47, 55 and 59 the maximum allowable discharge temperature is 220°F.

**SPEED RANGE** — RAI blowers may be operated at speeds up to the maximums listed for the 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.

Table 1—Maximum Allowable Operating Conditions

Frame Size	Speed RPM	Inlet Vac. Inches Hg.	Temp. Rise Fahr. Deg.	Press Rise PSI
33	3550	12	190	6
36	3550	7	115	3.5
44	2850	10	120	6
47	2850	7	90	3.5
53	2300	12	160	10
55	2300	12	120	6
59	2300	7	65	3.5
65	1900	16	230	10
67	1900	12	155	7
610	1900	10	115	6
615	1900	7	75	3.5
74	*1640	16	332	13
76	*1640	16	245	10
710	*1640	12	245	6
717	*1640	7	85	3.5
86	1450	16	195	13
88	1450	16	220	10
812	1450	12	145	6.5
820	1450	8	90	4

\*May be up to 1750 RPM, if direct coupled only.

## INSTALLATION

Roots Type 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.

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 of 3½" through 8" diameter. 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.

quired to install them. Maximum deviation in offset alignment of the shafts should not exceed .005" total indicator reading, taken on the two coupling hubs. Maximum deviation from parallel of the inside coupling faces should not exceed .001" when checked at six points around the coupling.

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 from the bearing end cover. The shaft fit should be such that the sheave can be worked into place by hand or by very light tapping. 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 driver 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 procedure 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 belts 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.
6. A new set of belts 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 gear-house per instructions under LUBRICATION.

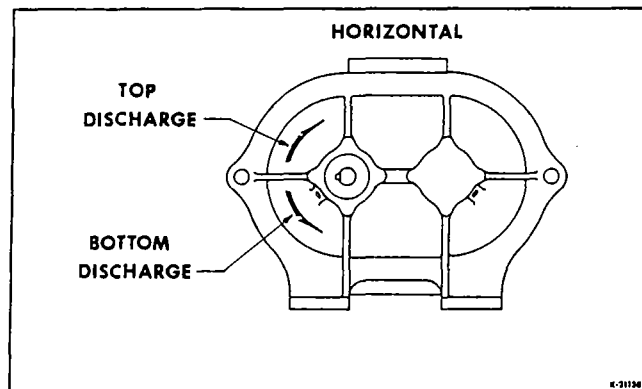
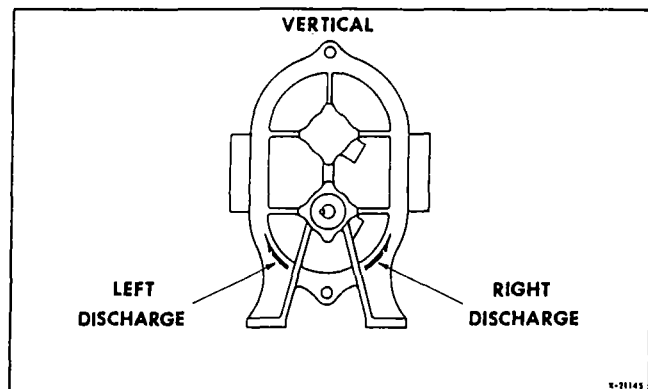


Figure 2 — Rotation and Piping Connections, Vertical and Horizontal RAI Blowers

providing good lubricant storage capacity. Pressures within the gearhouse are vented through an internal vapor filter.

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 secondary oil sump.

**Before starting blower**, be sure oil has been put in gearhouse, as ALL OIL WAS DRAINED FOLLOWING SHOP TESTS. For recommended lubricating oil see Table 2.

Table 3 — Oil Sump Capacities

Blower Size (First Figure)	Sump Capacity—Fluid Oz.	
	Side Inlet	Top/Bot. Inlet
3	8	11
4	11	13
5	16	20
6	18	32
7	22	48
8	2 qts.	5 qts.

To fill the gearbox on blowers which are provided with a sight gauge (RAI-58), remove the oil filler plug (Item 22, Fig 7) from the gear housing and fill the reservoir to slightly above the lower line on the sight gauge. Wait several minutes for the oil level

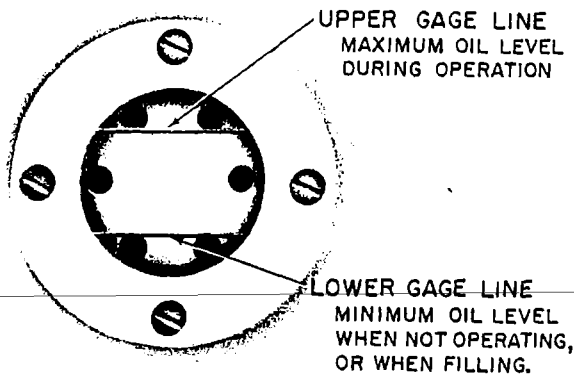
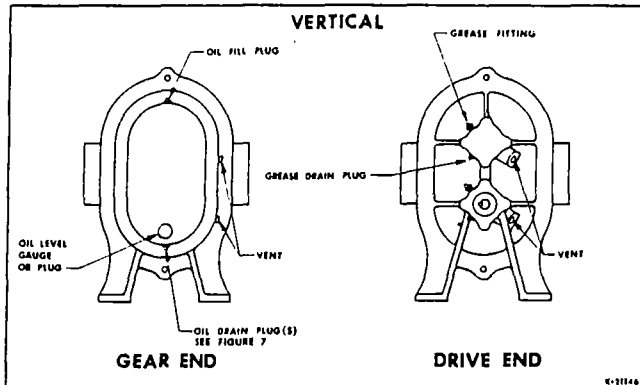


Figure 5. Correct Oil Levels on Sight Gauge



to equalize between the two sumps in the gearhouse, and add more oil as needed; the static level should never be allowed to fall below the lower gauge line. During operation the oil level will rise on the gauge, to an extent depending somewhat on temperature of the oil, but it should not be permitted to rise above the upper gauge line.

On blowers not provided with a sight gauge (RAI-65), to fill the gearbox, remove the oil filler plug (item 22) and the oil overflow plug (item 37). Fill the reservoir up to the overflow hole. Wait for the levels to equalize between the two sumps, and then add more oil, if necessary, to bring the final oil level up to the overflow hole. Place the oil filler plug and the overflow plug back into their respective holes.

When servicing drive end bearings, use a premium grade grease with high temperature and moisture resistance and good mechanical stability. After a long shutdown, it is recommended that the grease drain plugs be removed, the old grease flushed out with kerosene or #10 lubricating oil, drained thoroughly, and bearings refilled with new grease. Be sure grease drain plugs are reinstalled.

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 gearhouse oil level and necessary addition of lubricant should be sufficient. A complete oil change

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 - 3600	1	1	1

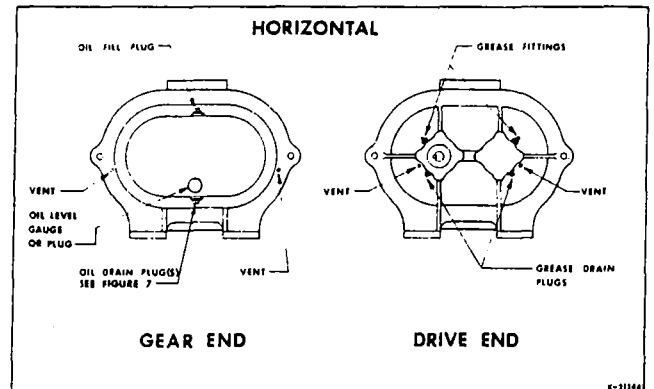


Figure 4 — Lubrication Points, Vertical and Horizontal RAI Blowers

# 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 Acknowledgment. Compare actual rotation with Figure 2. Change driver if wrong. Check piping, 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 Acknowledgment. See Item 5. Inspect outside of cylinder and headplates for high temperature 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 drive end bearings. Check gear oil level. If correct 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	

nel 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.
- 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.

## DESIGN

The RAI blower is available in two different configurations — one with side cylinder connections (Vertically mounted or Type V) and the other with top and bottom cylinder connections (Horizontally mounted or Type H).

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 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. Simplest treatment is to spray or flush the interior with a mixture of light oil and kerosene, making sure it reaches all surfaces. Piping should be disconnected first, and the connections sealed after treatment. Before putting back in service, check internal condition visually and rotate the drive shaft by hand.

If preferred, a commercial compound may be used instead of kerosene-oil for protection. Among suitable ones is Nox-Rust 207, marketed by Daubert Chemical Company. Best applied by spraying at 120°F, it may also be brushed on. Special care should be taken to insure good coverage between ends of the impellers and the headplates. After completing the application, seal all blower openings with vapor barrier paper or tape.

This protection is normally effective for about one year. Before returning blower to service, inspect all internal surfaces. If dirt of any kind is found, clean all surfaces thoroughly with a good petroleum solvent. Otherwise, blower may be connected and operated without cleaning. Be sure tape or plug is removed from vent hole near bottom of each headplate.

It is recommended that major repairs, if needed, be performed at the Factory or at a Dresser 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 Figure 7 and Table 7. 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, Figure 7, and parts list, Table 7. It is recommended that the procedures 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(s) (21) in the bottom. (Note there is only one plug in "65"). 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. On the exposed end of each shaft make a punch mark near the edge and exactly in line with the large end of the gear taper pin. This will locate the taper pin hole because the gears must be re-pinned at a right angle to the old hole. This is discussed further in step 11. Reach through one of the blower pipe connections and place a chalk mark on the lobe of one impeller and the mating waist of the other, so that they may easily be returned to their original relative positions.

3. Support each gear hub in turn on a block and drive out the taper pins from the small end, turning the gears as necessary. Remove the gears by means of a gear puller, which clamps around the grooved gear hub. Do not attempt to remove the gears by other means, such as bumping, as this will cause damage to impellers or bearings.

4. Remove any burrs on the shafts, but do not work them down to make a looser gear fit. Also check the shaft holes in the new gears for burrs, and wipe clean. Be sure gears are a matched pair (with same numbers). Using white lead mixed with machine oil, or a heavy grade of oil alone, coat the shafts and the inside of shaft holes in the gears.

5. Make sure impellers are in correct position as previously marked. If blower is an RAI-65, place 0.003 in. feeler between the headplate and the ends of the impellers at the drive end. This will prevent damage to the impeller hubs when driving the gears.

16. When clearances are correct, clean and re-install the gearhouse. Make sure the small orifice hole near the bottom of the partition wall is completely open. Check condition of flange gasket (7) and replace if questionable. Fill gearhouse to correct level with proper grade of oil.

## B — Replacing Shaft Bearings, Seals and Impellers

Remove coupling or sheave from the drive shaft and disassemble outboard bearing bracket if installed. 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 covers at the drive end. On an RAI-58 blower the shims (10), behind the end cover flanges should be taped together and marked for reassembly with the same covers. O-rings (34) may remain on the covers if not damaged. Also remove bearing locknuts (50) and lockwashers (31) from both shafts.

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 the shaft oil seals and bearings with it. In an RAI-58 unit it will also bring out bearing locating washers (29). Make sure the latter are kept separated and identified for return to the same bearing pocket in the headplate.

4. 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 the cylinder is long, or 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 oil seals and bearings. Use a round bar or tube that will just pass through the shaft clearance holes in the headplates. The seals will be damaged in this operation and must be replaced. Note that the RAI-65 blowers employ self-sealed bearings on the drive end instead of separate seals and open bearings.

7. Clean bearing and seal pockets in both headplates, and remove burrs or rough edges. Press new seals into place, 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, and the seal face should be flush with the shoulder in the headplate. Apply a light coat of oil

(gear end) or grease (drive end) to the inside surface of the seal lips.

8. Assemble gear end headplate to cylinder after checking flange punch marks. Drive in the two locating dowel pins before tightening flange screws.

9. 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.

10. Install new bearings at gear end. If blower is an RAI-65, first place 0.003 in. feeler between impeller ends and headplate. Push bearings onto shafts and press or tap into headplate until approximately 3/8 in. below its machined face. Use a tube with flanged end that will contact both bearing races simultaneously.

11. Assemble drive end headplate to cylinder after first removing all sharp edges from shaft shoulders and keyway.

12. On an RAI-65 blower install bearings in same manner as at gear end. On an RAI-58 blower, first place bearing locating spring washers (29) in the bearing recesses, using the same quantity in each recess as employed in original assembly. Then install bearings carefully, seating the inner races against the shaft shoulders. Place locknut spacer sleeves (45) against the bearings, followed by lockwashers and locknuts. (Note that item (45) is not used on units of 5 in. gear diameter.) Tighten both locknuts firmly and bend down lockwasher tabs to secure the nuts.

13. Install gears and time impellers as in (A).

14. On an RAI-65 blower, set the impeller end clearances equal at both ends by tapping on the shaft ends. Install drive end covers (5) and (6), after packing bearing cavities with suitable grease. Replace drive shaft seal (33) if its lip condition is questionable. Lip must point toward the bearing. Exercise care not to damage the lip as it passes over shaft keyway.

15. On an RAI-58 blower the drive end covers must be installed and tightened before drive and impeller clearances can be set. Replace O-rings (34) and drive shaft seal (33) if damaged, lubricating both lightly with grease. Place shim packs (10) behind the end cover flanges with which they were originally installed and tighten all flange screws. Check and adjust impeller drive end clearances as discussed in step (14) of A. Pack bearing cavities with grease.

16. Install the gearhouse after cleaning out the inside and making sure the partition orifice is completely open. Fill with correct grade of oil to the lower gauge line.

17. Reinstall coupling or bell sheave, and the outboard bearing bracket if included in the assembly.

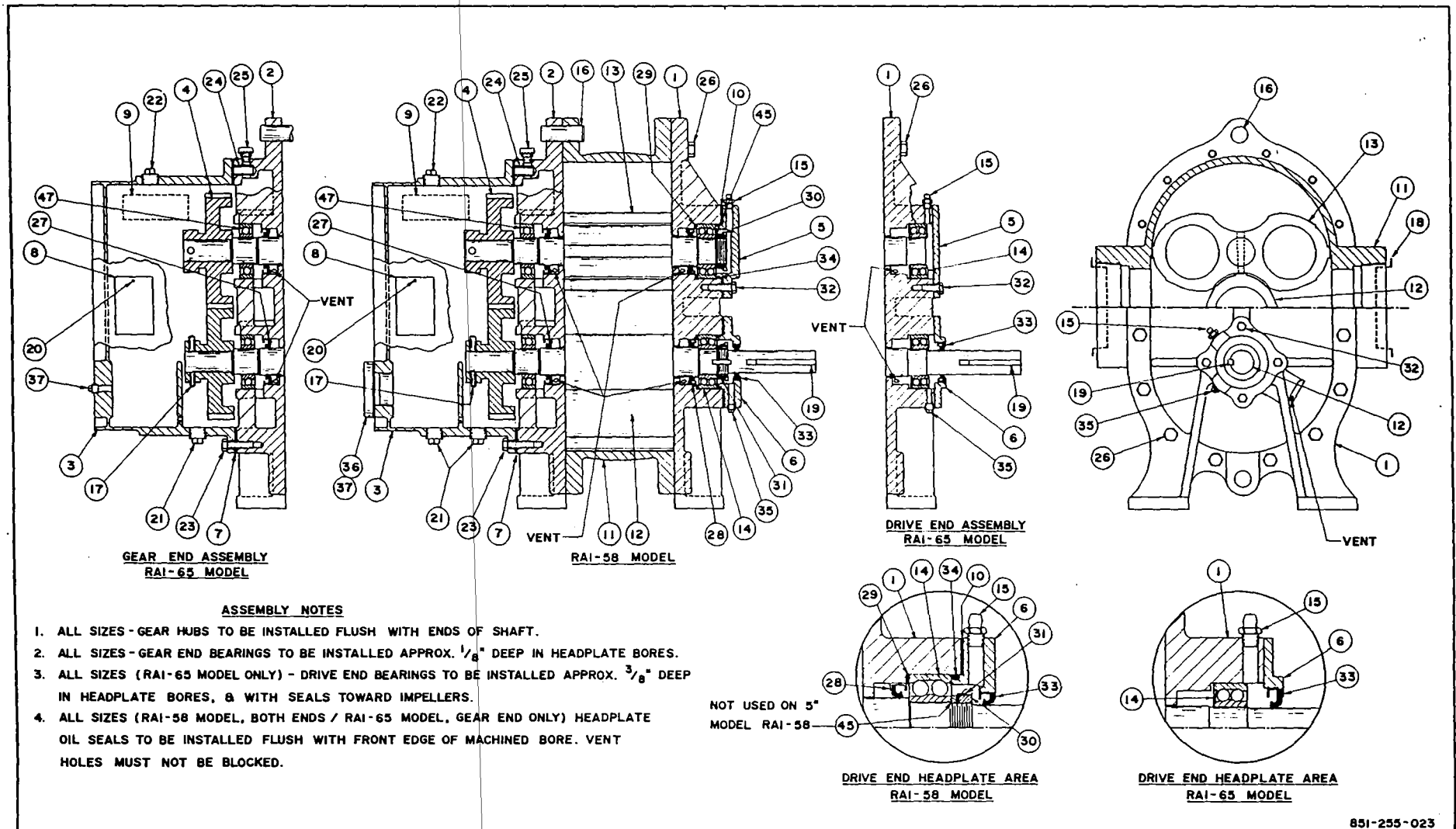


Figure 7 — Assembly of RAI Blowers