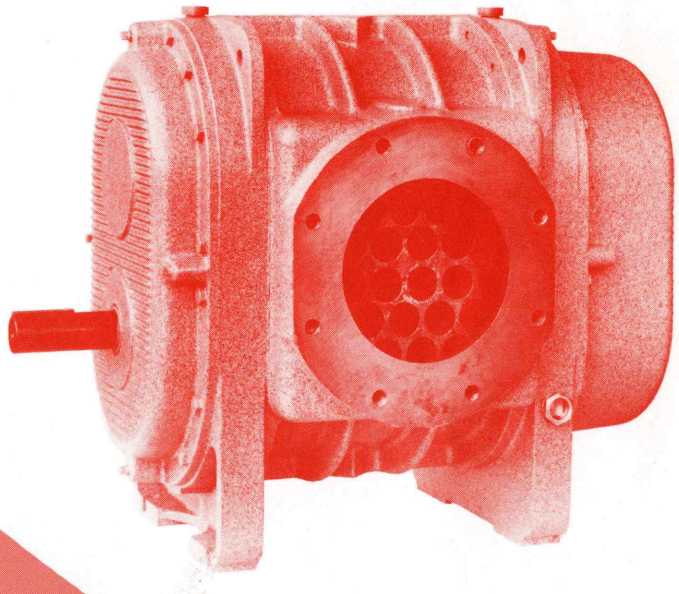
SUTORBILT®

BULLETIN RML-4

INSTALLATION OPERATION MAINTENANCE

MANUAL

Series 4500



SECTION I

OPERATING PRINCIPLES

The Fuller 4500 Series rotary blowers are the positive displacement type with two figure-eight shaped impellers rotating in opposite directions inside the casing. As each lobe of an impeller passes the blower inlet, it traps a quantity of air equal to exactly one-fourth the displacement of the blower. This entrapment occurs four times per revolution. The entrained air is forced around the case to the blower outlet. Timing gears accurately position the impellers in relation to each other to maintain the minute clearances so vital to the high volumetric efficiency of the rotary positive blower.

Equipment Check

Immediately after receipt of the equipment, a careful check should be made to insure that all items shown on the packing list have been received and have not been damaged in shipment.

A claim should be registered with the carrier for damaged or lost items of the shipment.

WARNING

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

Installation

Lifting and Handling

Reasonable care should be taken during unloading and moving to insure against undue strain on the blower.

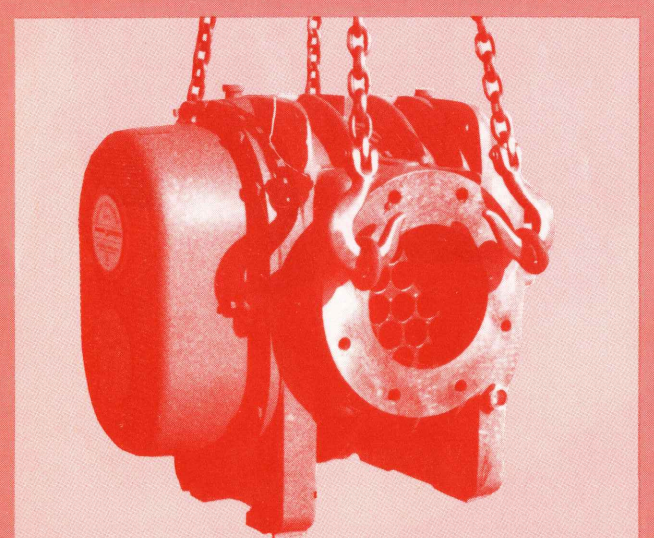


FIGURE NO. 1

Installation (Cont'd.)

When eye bolts or lifting lugs are used for support, it should be pointed out that they are designed and intended to be strong enough to handle the weight of the blower only. See figure 1.

Protective covers and rust preventatives should be left in place until just prior to installation.

Foundation

For permanent installation, we recommend concrete foundations be provided, and the equipment should be grouted to the concrete. It is necessary that a suitable base be used, such as a steel combination base under blower and motor, or a separate sole plate under each. Before grouting, equipment must be level, free of all strains, and anchored so no movement will occur during setting of grout.

After grout has completely hardened, a recheck is necessary to compensate for shrinkage, etc. If required, add shims under blower feet to obtain final level and alignment.

Where jack screws or wedges are used during grouting, they must be backed off or removed before final tightening of anchor bolts.

Where a concrete foundation is not feasible, care must be taken to insure anchoring to firm structural members.

Alignment

Series 4500 machines have internal thrust bearings to maintain impeller axial position whether belt driven or direct coupled to driver. When belt driven, faces of sheaves must be in line after proper belt tension has been achieved. On direct connect units, alignment and lubrication of couplings should be made in accordance with specifications of coupling manufacturers.

When mounted drives are supplied from the factory, proper alignment has been established before shipment. However, during shipping, handling and installation it is likely that the alignment has been disturbed and final adjustment must be made before start up.

Sheave should be mounted as close as possible to drive cover.

Rotation

Series 4500 blower and gas pumps are assembled for rotation in ONE DIRECTION ONLY. To achieve the quiet operation characteristic of the 4500 machines, the intake and discharge parts are not interchangeable. Proper rotation is shown by the directional arrow over the drive shaft extension.

Removing Protective Materials

The shaft extension is protected with rust preventive which can be removed with any standard solvent.

Blower inlets and outlets are temporarily capped to keep out dirt and other contaminants during shipping. These covers must be removed before startup.

The internal surfaces of all Sutorbilt units are mist sprayed with a rust preventative to protect the machine during the shipping and installation period. Remove this film upon initial startup, using any commercial safety solvent. Pour the solvent slowly into the inlet side of the machine while running until the unit is visibly clean.

Safety Precautions

All rotating parts should be protected by guards to eliminate hazards to operating personnel. All inlet openings should be protected by screens to prevent the entrance of foreign objects. Wherever possible, interlock systems should be employed to prevent start up when a hazardous condition exists.

Relief valves should be installed in the system to prevent excessive load from being applied on the unit during operation. Initial and periodic checks should be made to insure that the relief valves are properly set so that the maximum pressure rating of the unit cannot be exceeded. See chart, page 10 for speed and pressure ratings for standard units.

Where reverse rotation is possible a check valve is recommended. When operating a unit with an open or exposed inlet or discharge, care should be exercised to avoid inlet suction and discharge air blast. Ear protection against noise may be required.

Maximum relief valve setting 10% above maximum pressure rating of blower.

Piping

Inlet and discharge connections on all blowers are large enough to handle maximum volume with minimum friction loss.

Excessive weight of piping and fittings will cause internal misalignment and premature wear. Never allow the blower to carry the weight of the pipe. If possible, a spool or sleeve-type expansion joint should be installed between the unit and the piping. Where a flexible connection is not practical, weight of rigid connection must be separately supported. It is important that system piping is clean and free from scale or debris before connecting to the blower. Pieces of weld rod or rags can cause serious damage to the machine if drawn into rotors during operation.

SECTION II

PRE-START

Lubrication

WARNING: Units are shipped without lubricating oil. Do not operate before lubricating.

Timing gears and bearings are kept constantly lubricated by a simple but highly effective splash system. At the drive end, oil is distributed by a heavy-duty oil slinger (A) on the **shaft. At the gear end, gear teeth are lubricated by being** partially submerged. The gear teeth serve as oil slingers for the gear-end bearings.

Filling Procedure

Remove vented fill plugs (B) from top of gear case and top of drive cover. Do not remove any other plugs from gear case or drive cover. (Note that fill plugs are drilled with a side hole to vent gear case and drive cover to atmosphere.)

Using any locally available lubricant listed in the accompanying table, fill each end until oil reaches mid-point in the sight glasses (C). Replace fill plugs. Always maintain oil level within sight in the glasses.

Oil should be changed ever 1,500 hours under normal service and more frequently if necessary. High operating temperatures require more frequent oil changes. To drain, remove drain plugs (D) at bottom.

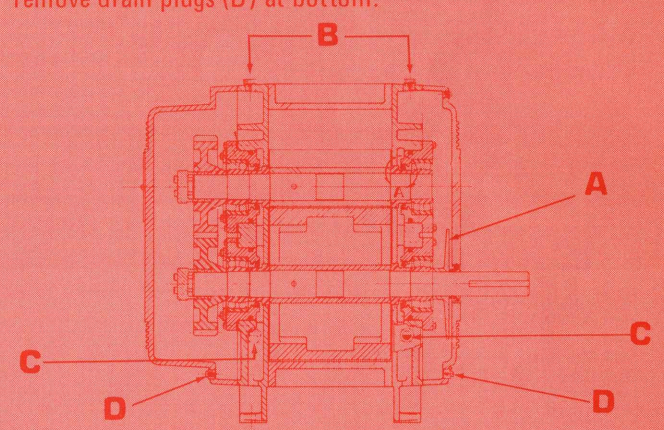


FIGURE NO. 2

LUBRICATION INSTRUCTIONS FOR OIL LUBRICATED GEARS AND BEARINGS

Add fresh oil as required to maintain proper level. Drain and refill every 1500 hours of operation under normal service, more frequently when required. Use a good quality oil.

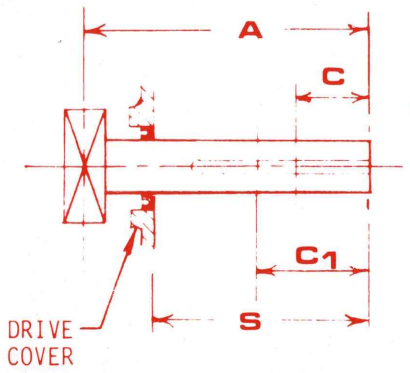
BLOWER DISCHARGE TEMPERATURE	OIL GRADE U.S.A.*	OIL VISCOSITY, CENTISTOKES @ 40°C
32° to 100°F (0° to 38°C)	SAE 20	65
100° to 275°F (38° to 135°C)	SAE 40	150
over 275°F (135°C)	SAE 50	250

*In applications with extreme variations in ambient temperature a 20W - 50 multiple viscosity oil is recommended.

For blower discharge temperature below 32°F (0°-C) consult the factory.

OVERHUNG LOAD TABLE

GEAR SIZE	DIMENSIONS A in.	A (Cm)	C in.	C (Cm)	S in.	S (Cm)	MAX. LOAD Lbs.	Kg.
6	6.60	(16.76)	1.75	(4.44)	4.50	(11.43)	850	386
7	7.87	(20.20)	3.00	(7.62)	4.87	(12.37)	975	442
8	9.50	(24.1)	4.30	(10.92)	6.80	(17.27)	1440	653



$$\text{Load} = \frac{2 \times HP \times \text{Constant}}{N \times r};$$

where N = rpm
r = sheave radius
HP = motor rating

Constant = 63025 English units

If drive sheave center is located at other than 'C' inches from drive shaft end, the revised maximum load can be calculated as follows:

$$\text{REVISED LOAD} = \text{Max. Load} \times \frac{A-C}{A-C_1}$$

This formula applies with C_1 greater or less than C.

NOTE: Formula must be modified if calculation is made in metric.

V-Belt Drive

For V-belt driven blowers the belts should be tensioned so that the manufacturer's limits are not exceeded and the blower overhung load limits shown in the above table are not exceeded.

Maximum Grooves and Minimum Sheave Diameter (All 5V Section)

UNIT SIZE	MAXIMUM NUMBER OF GROOVES	MINIMUM SHEAVE DIAMETER
6"	4 grooves	10.3" O.D. (26.2 Cm)
7"	4 grooves	10.3" O.D. (26.2 Cm)
8"	5 grooves	10.9" O.D. (27.7 Cm)

System Check

Insure that the piping and air system are clean and free of debris or obstruction. Inlet and discharge air valves should be open during start.

Follow necessary safety precautions to make certain the system is ready for operation. Check operation of safety devices to see that they are adjusted and functioning properly.

Start Up

PINCH POINTS **WARNING!**

Keep hands, feet, etc., foreign objects and loose clothing away from inlet and discharge openings to avoid injury or damage if impellers are to be rotated.

Rotation

Turn shaft manually at least one or two full turns to make certain rotors are clear and that no internal binding occurs.

OPERATION

NOISE **WARNING!**

Do not operate equipment without adequate silencing devices installed since high noise level may cause hearing damage. (Reference OSHA standards).

After the unit has been started, the load should be applied gradually.

The first few minutes of operation are the most critical, in so far as potential problems are concerned, so all equipment should be observed closely for excessive heat, noise or vibration during this period. Speeds, pressures, temperatures, vacuums and other operating conditions should be checked to insure that specified limits are not exceeded.

Routine Operation

Since the unit is a positive displacement type, the volume flow is fixed for constant speed so no regulation can be achieved by restricting the pipe or adjusting valves. Excess air flow may be discharged through a relief valve or blow-off to atmosphere. Volume flow is essentially proportional to speed and this offers a method of flow adjustment with V-belt driven machines.

Although these units are extremely rugged and are designed with adequate factors of safety, it is possible to cause serious damage by exceeding the manufacturers limits to any great extent. Limits shown on Page 10 should not be exceeded without factory approval.

Periodically the gauges, instruments and safety devices used to monitor the blower should be checked for calibration and functioning.

NOTE: Full rated pressure is full pressure differential from inlet flange to discharge flange.

Shut Down

In most cases it is preferable that the blower be unloaded before shut down. In any event consideration should be given to possible backflow and reverse rotation of the equipment as a result of pressure on the discharge side of the unit. The use of a check valve will prevent reversing.

Precaution should be taken to insure that the unit cannot be started accidentally and cause injury to personnel or damage to equipment.

If the unit is to be shut down for extended periods of time, it may be desirable to take some steps to prevent rust forming inside the casing. Condensation, gas vapors, or sea water can close up internal clearances and cause the unit to bind. Injection of oil or other rust retardant will help to prevent this problem.

SECTION III

MAINTENANCE

GEAR INSPECTION

Inspection of the timing gears and gear end bearings may be accomplished simply by removing the gear case. Refer to Fig. No. 3. Remove bolts from the gear case and detach it from the head plate. Timing gears and gear end bearings are now exposed. On completion of maintenance work, be certain that the gear case is restored to original position. Use a paste-type gasket compound on the mating surfaces. Always relubricate before starting.

IMPELLER INSPECTION

Series 4500 impellers can be inspected through the intake port only. This will reveal such conditions as out of time, excessive or insufficient clearances, abrasion of parts from passing foreign material, etc.

REPAIR

ASSEMBLY **WARNING!**

When rotation of the impellers is required in the assembly process insure that all personnel are clear of lobes and gears to guard against serious injury.

TIMING

The impellers are separated by pre-determined exact clearances built into the machine. "Timing" of a unit is the setting of one impeller with respect to the others so they do not touch or knock during normal operation. The impellers are held "in time" by gears which are secured on the shaft by grip rings inside the gear hubs. See figure No. 3. Retiming is necessary to restore proper impeller lobe to lobe clearance after a unit has been jammed and removal of the strain or foreign material does not stop the knocking during operation.

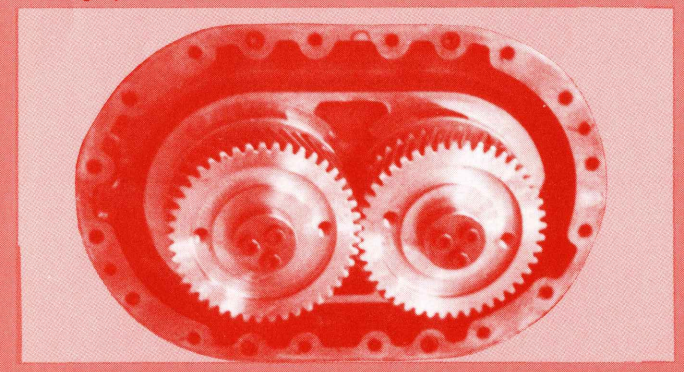


FIGURE NO. 3

BLOWER SIZE	IMPELLER CLEARANCES GEAR END MIN-MAX inches	Cm	IMP. TIP EACH MIN-MAX inches	Cm	DISCHARGE TIMING MIN. inches	Cm
6	.007-.008	.017-.020	.006-.008	.015-.020	.005-.011	.012-.028
7	.007-.008	.017-.020	.006-.010	.015-.025	.006-.013	.015-.033
8	.007-.008	.017-.020	.006-.011	.015-.028	.006-.013	.015-.033

FIGURE NO. 4

DETERMINING PROPER IMPELLER CLEARANCES

Refer to Fig. No. 5. Impellers are shown viewed from the drive end of the blower. Always face the drive shaft end when determining clearances. Select the illustration which represents your unit.

Clearances between impellers are measured at points o-o and c-c when the impellers are positioned at 45° angles as shown. This is done by measuring with a feeler gauge between o-o, then rotating the impellers a quarter turn and gauging between c-c. Adding the measurements obtained will give the total clearance.

Units are timed for rotation in one direction only, and are marked with a rotational arrow above the drive shaft. In these units, o-o should have 2/3rds of the total clearance and c-c should have 1/3.

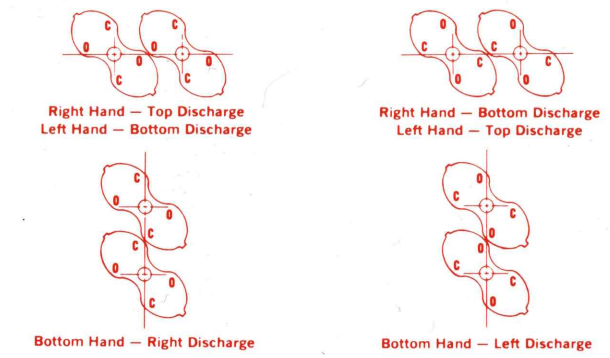


FIGURE NO. 5

RESETTING IMPELLER CLEARANCES

Impellers are held in time by the timing gears, which are secured in position on the impeller shafts by grip rings inside the gear hubs. To reset impeller clearances (timing) it is necessary to release the grip rings in one of the gears. (See Fig. No. 6).

Grip rings are paired telescoping rings with conical mating surfaces. These rings are telescoped under clamping pressure so that the outer ring expands against the bore of the gear while the inner ring contracts on the shaft, locking them together.

To release the grip rings in one of the gears, first remove the gear locking clamp which is held to the end of the impeller shaft by three cap screws. Use a gear puller to withdraw the gear about 1/8 inch (3 mm), then lightly tap the side of the gear with a mallet. This will release the grip rings inside the gear hub so that the impeller will be free to adjust. Do not remove the gear.

Wedge the two impellers together against the exact amount of shims required to establish proper clearance as determined previously. Push gear firmly against bearing race on the shaft. Replace the gear locking clamp and cap screws. Partially tighten the cap screws with the shim stock still wedged between impellers. Proceed to tighten the cap screws progressively, finishing with a torque wrench to obtain a torque of 65 ft. lb. (9 Kg-m). Shock-load the gear locking clamp and then retorque to 65 ft. lb. (9 Kg-m). Remove shim stock and turn the impeller a couple of turns, then recheck the clearances.

END CLEARANCE: It is always good policy to check end clearance between the impeller and gear-end headplate BEFORE AND AFTER DISTURBING TIMING GEARS OR GEAR-END BEARINGS. If end clearance is not within tolerance, see Bearing and Seal Replacement instructions for making correction by re-shimming the bearing cartridge. After completion of work replace gear case and relubricate.

TROUBLE SHOOTING

No matter how well equipment is designed and manufactured, there may be times when servicing will be required due to normal wear, the need for readjustment, or various external causes. Whenever equipment needs attention, the operator or repairman should be able to locate the cause and correct the trouble quickly. The following Trouble Shooting Chart will assist the mechanic in those respects.

PROBLEM	POSSIBLE CAUSES	SOLUTION
Knocking	Unit out of time	Retime. See Page 5.
	Distortion due to improper mounting or pipe strains	Check mounting alignment and relieve pipe strains.
	Excessive pressure differential	Reduce to manufacturer's recommended pressure. Examine relief valve, re-set if necessary.
	Worn gears	Replace timing gears. See Page 7.
	Worn bearings	New bearings. See Page 8.
	Worn bearing cartridges	Replace cartridges. See Page 8 & 9.
Excessive blower temperature	Too much oil in gear case or drive cover	Reduce oil level. See Page 3.
	Too low operating speed	Increase actual blower speed.
	Clogged filter or muffler	Remove cause of obstruction.
	Excessive pressure differential	Reduce pressure differential across the blower.
	Worn impeller clearances	Restore clearances.
Impeller end or tip drag	Insufficient assembled clearances	Correct clearances.
	Case or frame distortion	Check mounting and pipe strain.
	Excessive operating pressure	Remove cause.
	Excessive operating temperature	Remove cause.
Lack of volume	Slipping belts	Tighten belts.
	Worn clearances	Re-establish proper clearances.
Excessive bearing or gear wear	Improper lubrication	Correct oil level. Replace dirty oil. See Page 3.
Loss of oil	Headplate, gear case or drive cover vents plugged	Clean vents.
	Worn seal	Replace seals. See Page 8.

REPAIR & REPLACEMENT

With proper maintenance and lubrication you can expect normal life of bearings, gears and seals. To maintain the efficiency of your unit, however, these parts must be repaired or replaced when required.

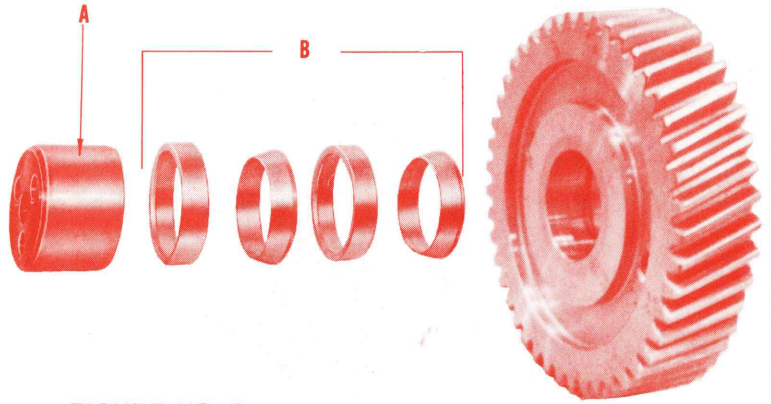


FIGURE NO. 6

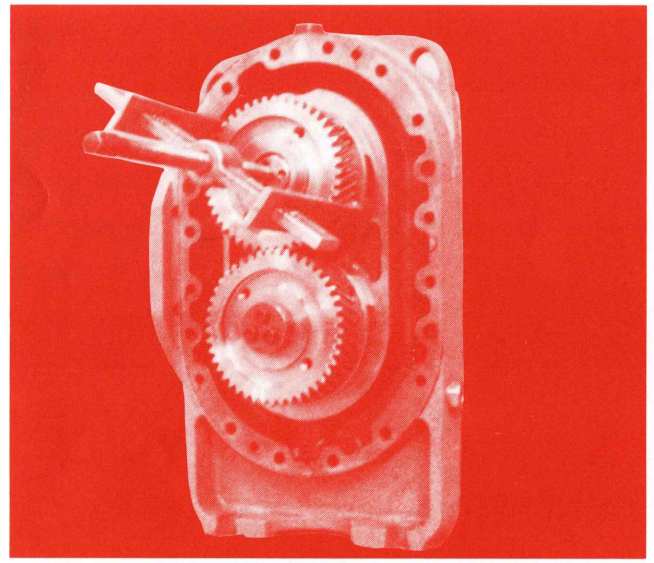


FIGURE NO. 7

TIMING GEAR REMOVAL

Remove the gear case (see Gear Inspection). Match mark the shafts and gears to assure proper repositioning on completion of work.

See Figs. No. 6 & 7. Remove the cap screws and gear locking clamps (A) from both shafts. Inside the hub of each gear are two pairs of telescoping grip rings (B) which secure the gear to the shaft. These grip rings must be released to remove the gear.

This is done by withdrawing the gear (Fig. No. 7) about 1/8 inch (3 mm) with a gear puller, then lightly tapping the side of the gear. This releases the rings and allows the gear to be removed by hand.

Note carefully the placement of the grip rings before removal, so that you can replace them properly paired and faced in the correct direction.

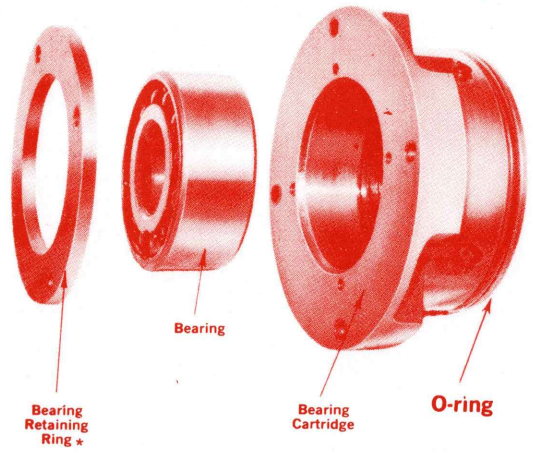
TO REASSEMBLE, locate each gear firmly against the bearing race on its shaft. Thoroughly clean and dry all components – the grip rings, shafts and gear bores: coat the grip rings with a light oil then slide the grip rings all the way into the gear bores. Be sure the rings are paired and faced identically as originally installed, as shown in Fig. No. 6. (Note: do not reuse grip rings which have been disassembled, since they lose concentricity and locking characteristics.)

Replace the gear locking clamps and cap screws. Establish a position for one gear, and progressively tighten the cap screws on that gear only. Using a torque wrench, finish at 65 ft. lb. (9 Kg-m). Shock-load the gear locking clamp and then retorque to 65 ft. lb (9 Kg-m). Then follow "Resetting Impeller Clearances" before tightening the second gear in the same manner.

Note end clearance between the impeller and gear head plate and correct if necessary according to instructions on next page. Replace the gasket, gear case and lubricate.

REPAIR & REPLACEMENT

BEARING AND SEAL REPLACEMENT



*Later models use (4) clips instead of solid ring.

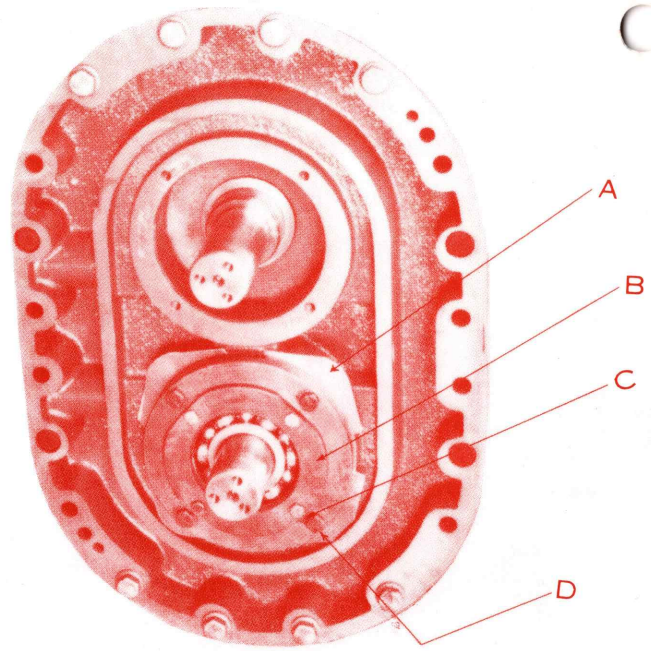


FIGURE NO. 8

GEAR END

Remove gear case (see Gear Inspection). Note end clearance between impeller and gear headplate. Remove timing gears as instructed previously.

Refer to Fig. No. 8. Shims (A) installed during manufacture will now be exposed behind the bearing cartridge (B). These shims set the end clearance between the impeller and headplate; hence it is important that they be returned to their exact positions on reassembly. (NOTE: The number of shims fastened behind each bearing cartridge bolt may vary; be sure each set of shims is identified by position during withdrawal). To remove the shims, remove the bearing cartridge bolts (C). Insert jack screws in tapped holes (D) provided in the cartridge and back out the cartridge until the shims are loose. Remove one attachment bolt at a time, taking out the shims and marking them for accurate repositioning. On removal of all bolts continue using the jack screws to complete the cartridge removal. Remove the bearing retainer ring (or clips), from the face of the cartridge.

Blowers have a lip type oil seal behind each bearing. Gas pumps have a mechanical seal.

LIP TYPE OIL SEAL

Whenever a cartridge is removed for repair purposes, always install a new seal and O-ring before reassembly. Install the seal with lip facing the bearing, using a driving instrument having approximately the same outside diameter as the seal. Use precaution not to damage the sealing elements, particularly when they are moved over the shafts.

REPAIR & REPLACEMENT

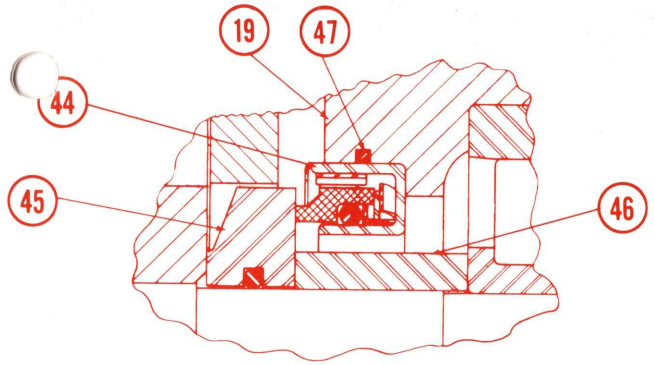


FIGURE NO. 9

MECHANICAL SEAL

Refer to Figure 9. When replacing, remove the old seal components. Clean the shaft carefully, especially under the O-ring inserted in the groove of mating ring, item 45. Before sliding item 45 into position, be sure to break the sharp edges at shaft diameter changes, and lubricate the shaft surface. Item 45 must fit tight against impeller end. Sleeve 46 is now installed on the shaft against Item 45.

The mechanical seal should be assembled into the bearing cartridge item 19 on the bench. First insert O-ring 47 into the groove. With light oil, lubricate the recess and press in assembly 44. Then carefully install the bearing cartridge with seal, into the headplate.

On completion of seal repair or replacement, install a new O-ring on the bearing cartridge. Return the cartridges to their respective shafts and restore the shims to their original positions. Replace bearings in cartridges and secure with bearing retainers or clips. Be sure inner races are against shaft shoulders.

END CLEARANCE

To check or establish the gear-end clearance, use a sleeve made to substitute for the gear and grip ring assembly. (Items 5 and 6 on the parts cross section illustration.) With the gear locking clamp in place over the shaft end, and against the spacer sleeve, tighten the cap screws to 5.4 kg. m torque. Check clearance between impeller ends and gear headplate. Add or remove shims behind cartridge flange to establish the clearance given in Fig. 4. Then remove the spacer sleeve and install gears, grip rings and locking clamps as outlined in Section III, under RESETTING IMPELLER CLEARANCES.

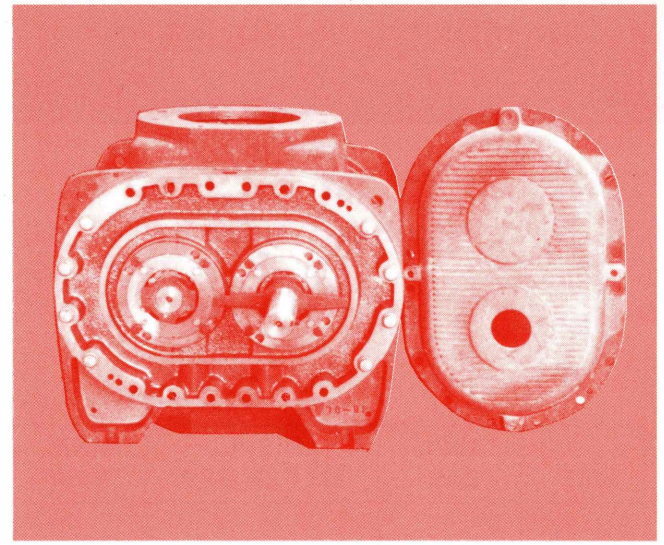


FIGURE NO. 10

DRIVE END

See Figure No. 10. Remove drive cover. Unbolt and remove oil slingers from each shaft noting their relative position for later replacement; spread slightly to avoid scratching shaft. The bearing cartridges can now be removed following the procedure described for the gear end, with the exception that no shims or bearing retainers will be found.

Re-install bearing cartridges with new seals and O-rings.

Replace bearings and slinger. Rotate shafts a couple of turns to be sure there will be no interference of the oil slinger. Remove old drive seal and install gasket and drive cover. Use a paste-type gasket compound between cleaned mating surfaces. Replace drive seal. Take extreme care to avoid damaging the seal when moving it over the shaft keyway. When reassembly is completed, lubricate.

TYPICAL PERFORMANCE DATA FOR SERIES 4500 BLOWERS

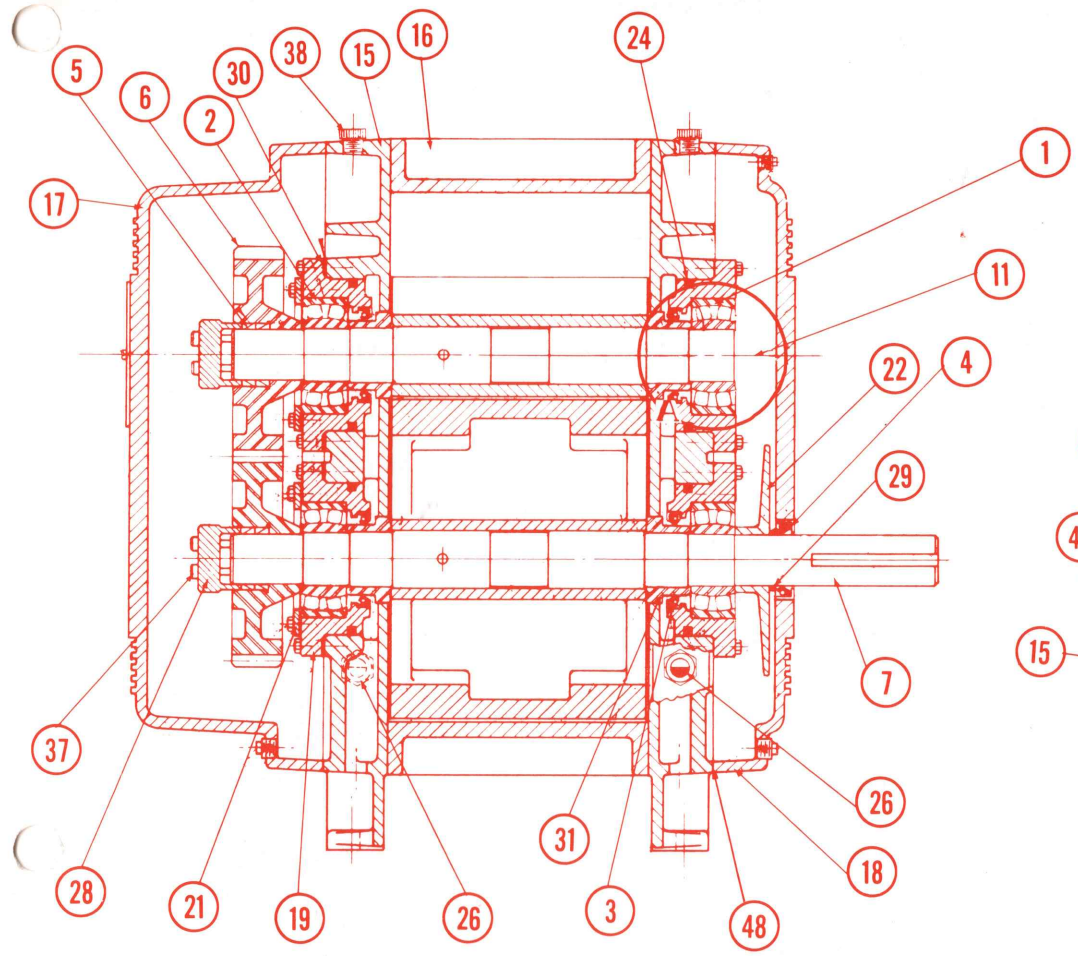
MAXIMUM CAPABILITIES AND LIMITATIONS OF THESE SIZES BASED ON AMBIENT CONDITIONS OF AIR AT STANDARD CONDITIONS

SIZE	DISPL. CFR	DISPL. M^3 PER REV.	MAX. RPM	*MAX. PRESS	MAX. PRESS. Kg/Cm^2*	BLOWER MAX. VAC.	MAX. VAC. mm Hg
608	.39	.011	2860	15 PSI	1.05	14" HG	356
612	.59	.0167	2860	10	.70	14	356
615	.73	.021	2860	8	.56	14	356
618	.88	.025	2860	6	.42	12	305
711	.73	.021	2450	15 PSI	1.05	14" HG	356
713	.87	.025	2450	10	.70	14	356
716	1.06	.030	2450	8	.56	14	356
721	1.40	.040	2450	6	.42	12	305
812	1.04	.029	2150	15 PSI	1.05	14" HG	356
816	1.39	.039	2150	10	.70	14	356
820	1.74	.049	2150	8	.56	14	356
824	2.09	.059	2150	6	.42	12	305

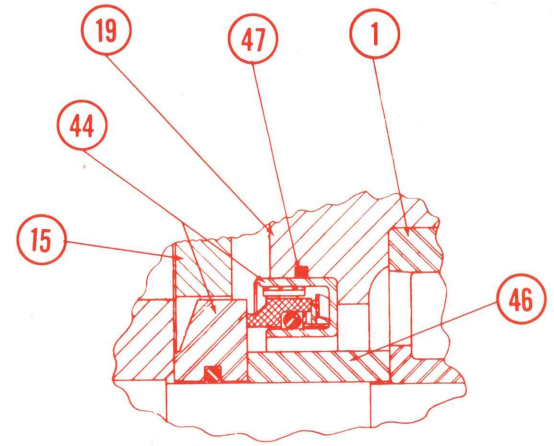
* SUBJECT TO OVERHUNG LOAD LIMITS FOR BELT DRIVE

MAXIMUM DISCHARGE TEMPERATURE 325° F (162° C)

TYPICAL PARTS DESCRIPTION



VIEW "A"



MECHANICAL SEAL
4500 MS Gas Pump Only

ITEM NO.	QTY.	DESCRIPTION	ITEM NO.	QTY.	DESCRIPTION
◣ 1	2	Main Bearing – Drive End	22	1	Oil Slinger
◣ 2	2	Main Bearing – Gear End	◣ 24	4	O' Ring – Bearing Cartridge
◣ 3	4	Main Seal	26	2	Oil Level – Sight Glass
◣ 4	1	Drive Seal	28	2	Gear Locking Clamp
◣ 5	4 PR.	Grip Rings	29	1	'O' Ring – Oil Slinger
◣ 6	1 PR.	Timing Gear	30	A/R	Thrust Shim
● 7	1	Long Shaft Assembly	31	4	Sleeve – Lip Seal
● 11	1	Short Shaft Assembly	37	6	Soc. Hd. Cap Screw
15	2	Headplate	38	2	Fill Plug – Vented
16	1	Impeller Case	□ 44	4	Mechanical Seal Assembly
17	1	Gear Case	45		
18	1	Drive Cover	□ 46	4	Sleeve – Mechanical Seal
19	4	Bearing Cartridge	□ 47	4	'O' Ring – Mechanical Seal
21	8	Bearing Retainer Clips – Gear End	◣ 48	2	Cover Gasket

NOTES:

1. WHEN ORDERING SPARE OR REPLACEMENT PARTS, PLEASE SPECIFY THE FOLLOWING: SIZE OF THE UNIT, SERIES NO., SERIAL NO., PART NAME AND PART NO.
2. SHAFT ASSEMBLIES MARKED THUS: ● CONSIST OF ONE SHAFT, ONE IMPELLER, TWO SLEEVES, & ONE GROOV-PIN FURNISHED ONLY AS A MATCHED PAIR
3. ITEMS MARKED THUS: ◣ ARE FACTORY RECOMMENDED SPARE PARTS
4. ITEMS MARKED THUS: □ ARE USED FOR GAS PUMPS ONLY