ROOTS DRESSER

XA

2½ - 7 inch gear diameter

INSTRUCTIONS

ROTARY LOBE GAS PUMP

CONTENTS

DO THESE THINGS..... *To Get The Most From Your Roots Gas Pump*

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.

Bulletin IRB-160-272

OPERATING CHARACTERISTICS

Roots Type XA Gas Pumps, as covered in this manual, range in basic frame size from 2½ inches through 7 inches gear diameter. Within each frame size are several case lengths, selected to produce reasonable steps in gas pump capacity ratings. The shorter lengths have lower volumetric capacities, but are capable of operating against higher pressures. All units are designated as gas pumps, and may be used for handling clean, non-corrosive gas or air in either pressure or vacuum service.

The Roots rotary lobe gas pump 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 gas pump is illustrated in FIGURE 1, where air flow is bottom to top from inlet to discharge with the left impeller rotating clockwise. In Position 1 it is delivering a known volume (A) to the discharge, while space (B) between the right 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 beside the left 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 gas (two by each impeller) and pushes them through to the discharge. The pumping capacity of a lobe gas pump 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 by-pass some of the gas, as shown in Figure 3.

No attempt should ever be made to control capacity 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 gas pump. Likewise, if a possibility exists that flow to the gas pump inlet may be cut off during normal operation of a process, then an adequate vacuum relief valve must be installed near the gas pump. A pressure type relief valve in the discharge line near the gas pump is also strongly recommended for protection against cut-off or blocking in this line.

When a belt drive is employed, gas pump speed can usually be adjusted to obtain desired capacity by changing the diameter of one or both sheaves. In a direct coupled arrangement, a variable speed motor or transmission is required, or gas may be by-passed back to the gas pump inlet. However, the volume of gas that may be continuously by-passed is limited by heat build-up, which will cause gas pump damage.

Refer such application problems to the nearest Sales Office for recommendations of a by-pass cooler.

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

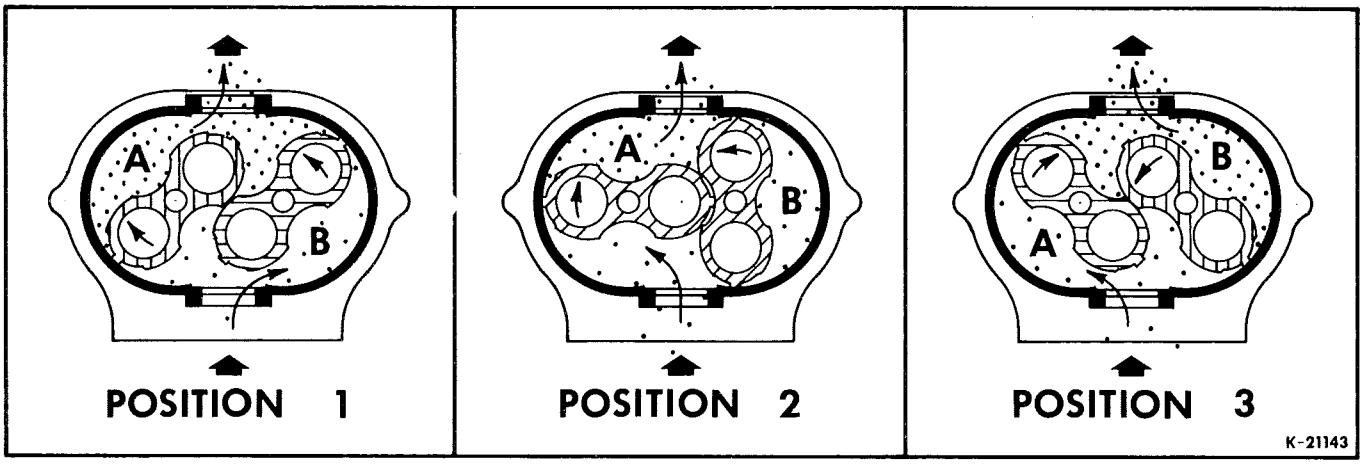


Figure 1 — Flow Through a Basic Type XA Gas Pump

OPERATING LIMITATIONS

To permit continued satisfactory performance, a Roots Type XA gas pump 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 XA gas pumps. These limits apply to all gas pumps of normal construction, having operating clearances as listed in Table 5 when operated under standard ambient conditions. **Do not exceed any of these limits.**

Example: The listed maximum allowable temperature rise (increase in gas temperature between inlet and discharge) for any particular gas pump may occur well before its maximum pressure or vacuum rating is reached. This can easily occur at high inlet vacuum 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 gas pumps. 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 gas pump inlet and discharge) must not exceed the figure listed for the specific gas pump frame size concerned. Also, in any system where the gas pump inlet is at a positive pressure above atmosphere, the discharge pressure must never exceed 14 PSI gauge regardless of gas pump 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 gas pump frame sizes are approved only for installation 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 gas pump. This is not outdoor temperature unless the gas pump 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. Maximum allowable discharge temperature is 400°F.

SPEED RANGE – XA gas pumps 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
22	2600	8	332	4.0
24	"	4	185	2.0
315	1850	12	332	6.0
33	"	8	190	4.0
36	"	4	115	2.0
42	1620	12	240	6.0
44	"	8	165	4.0
47	"	4	90	2.0
53	1300	12	160	6.0
55	"	8	120	4.0
59	"	4	65	2.0
65	1080	12	230	8.0
67	"	8	155	4.0
610	"	8	115	4.0
615	"	4	75	2.0
76	925	12	245	8.0
710	"	8	145	4.0
717	"	4	85	2.0

INSTALLATION

Roots Type XA gas pumps 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 gas pump until ready to start installation, as protection will be lost quickly by evaporation.

The 2½" thru 5" gas pumps are designed for indoor operation and should not be installed outdoors without proper protection. Pump sizes 6" and 7" are suitable for outdoor installation.

Important requirements are that the correct grade of lubricating oil be provided for expected temperatures, and that the gas pump 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 gas pumps of 2½" through 7" 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. Gas pump mounting must be solid, without strain or twist, and piping must be clean, accurately aligned and properly connected.

A bare gas pump without base should be lifted by a rope sling, with one loop passing under the gearhouse and the other loop under the cylinder.

When a gas pump 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 gas pump casing or mounting feet, or on any mounted accessory equipment.

Before starting the installation, remove plugs, covers or seals from gas pump 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 petroleum solvent such as DuPont Triclene D. 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 gas piping. Washing out is not required if the interior is found to be clean and compatible with the gas being pumped. The corrosion inhibitor used will vaporize and disappear during operation.

Care, plus consideration of all possible problems, will pay dividends when arranging the gas pump mounting. This is especially true when the gas pump 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 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 gas pump and driver.

For a gas pump 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 1-¼ inches 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 gas pump is mounted. It should have properly sized studs or tapped holes located to match the gas pump foot drilling. As an alternative, smaller plates at each end of the gas pump may be used. This is more complicated, usually makes leveling more difficult, and can produce twist or strains in the gas pump. Use of a high quality machinist's level is important.

With the mounting plate in place and leveled, set the gas pump 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 gas pump 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 pump shaft. Best arrangement is for the gas pump to be bolted directly to the mounting plate while the driver is on shims of at least 1/8 inch 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 gas pump 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 gas pump shaft by hand. It should turn freely at all points. Loosen the gas pump 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 gas pump 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 gas pump, consider how piping arrangements are dictated by the blower design and assembly.

DIRECTION OF ROTATION

STANDARD ASSEMBLY is with drive shaft at left when facing shaft end of pump; rotation should be clockwise to produce standard top discharge. When shaft is at the right, counter clockwise rotation should be used. Pumps having serial numbers starting with "48" or higher may be operated with rotation reversed from the above. without re-timing the gears. **However, on frame size 42 and larger units this will subject the shaft seals to discharge pressure, and may lead to leakage.**

On these larger units the headplates have an "equalizing chamber" which connects the shaft seals to the inlet side of the cylinder. This places the shaft seals under the inlet or lowest pressure rather than the higher discharge pressure. (See Figure 6 for a sectional view of the shaft seals and equalizing chamber.)

When a gas pump is DIRECT COUPLED to its driver, the driver RPM must be selected or governed so

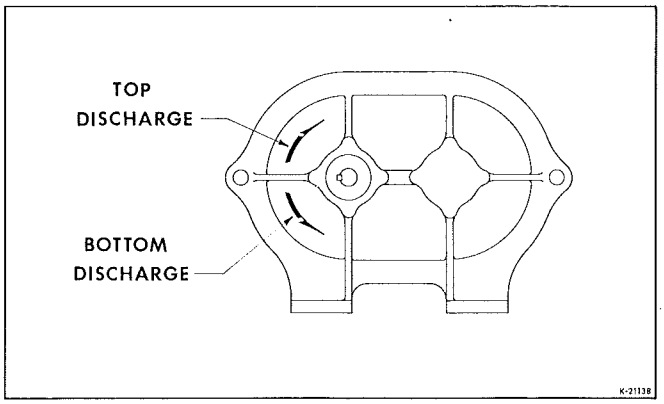


FIGURE 2—PIPING CONNECTIONS FOR DIFFERENT SHAFT ROTATIONS

as not to exceed the maximum speed rating of the blower. Refer to LIMITATIONS for allowable speeds for various gas pump sizes. A flexible type coupling should always be used to connect the driver and gas pump shafts.

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.

Should coupling manufacturer's instructions not be available, the following requirements for a good installation are recommended. Coupling halves must be fitted to the two shafts so that only light tapping is required 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 gas pump is BELT DRIVEN, a proper selection of sheave diameters can usually be made to adapt any standard driver speed to the required gas pump speed. This flexibility can sometimes lead to operating temperature problems caused by gas pump 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 gas pump 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 gas pump sheave (usually the larger one) so that its inner hub face is not more than ¼ 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 gas pump 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 gas pump, and mount the assembly so that the face of the sheave is accurately in line with the gas pump 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 gas pump is operating under load. *Excessive tightening* can lead to early bearing failures.

Failure to properly align the gas pump 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 gas pump 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 gas pump 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 gas pump 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 gas pump connections. Pipe used should be no smaller than these connections, and clean, new piping throughout is strongly recommended. 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 gas pump, 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 gas pump may cause serious damage.

Pipe threads must meet the gas pump connections accurately and squarely. Do not attempt to correct misalignment by springing or cramping the pipe. In most cases this will distort the gas pump 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 gas pump to eliminate dead weight strains. Also, if pipe expansion is likely to occur from temperature change, installation of flexible connectors or expansion joints is advisable.

Figure 3 represents in diagram form a gas pump 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 gas pump inlet. This will protect against gas pump overload caused by accidental closing.

Need for an inlet and/or discharge silencer will depend on blower speed and pressure, as well as sound-level requirements in the general surroundings. Specific recommendations on silencing can be obtained from the nearest Sales Office.

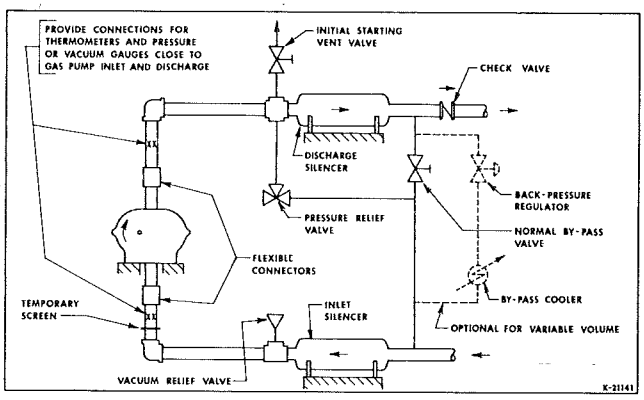


FIGURE 3—GAS INSTALLATION WITH ACCESSORIES

Discharge piping requires a pressure relief valve, and should include a manual unloading valve to permit starting the gas pump 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 gas pump operating conditions. If volume demands vary while gas pump operates at a constant speed, the excess flow can be by-passed to the gas pump inlet. The by-pass loop, shown in Figure 3, will normally require a back-pressure regulator and cooler. However, the volume of gas that may be continuously by-passed is limited by heat build-up which will cause gas pump damage.

Refer such application problems to the nearest Sales Office for recommendations of a by-pass cooler.

In multiple gas pump 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 gas pump discharge line. Properly installed, they will protect against damage from reverse rotation caused by air back-flow through an idle gas pump.

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 gas pump more than briefly at this time because of possible inadequate oil supply in the gearhouse. Read LUBRICATION section.

LUBRICATION

Shaft bearings at the gear end of the gas pump are splash lubricated by both gears dipping into an oil sump located in the gearhouse. **Before starting the gas pump,** fill this sump as instructed below. Recommended oil grades for various operating conditions are listed in Table 2. Quantities required to fill sumps in the different gas pump frame sizes, are listed in Table 3.

TABLE 2—RECOMMENDED OIL GRADES

Ambient Temperature	Discharge Pressure-PSIG	Viscosity SSU @ 100°F	Approx. SAE No.
Below 90°F	Below 2.0	500-700	30
Over 90°F	Below 2.0	700-1000	40
Below 90°F	Over 2.0	700-1000	40
Over 90°F	Over 2.0	1000-1200	50

To fill oil sump, remove oil fill and oil level pipe plugs in the gearhouse, as indicated in Figure 4. Fill until oil starts to run out from the oil level hole, then replace the fill plug. DO NOT replace oil level plug until the oil has stopped running out. This avoids over- lubrication, as to much oil causes heating and oil leakage.

TABLE 3—OIL SUMP CAPACITIES

FRAME SIZE	CAPACITY FL. OZ.
2½"	4
3½"	6
4"	10
5"	15
6"	26
7"	38

When gas pump is being operated, check gear house oil levels regularly at shutdown periods, and add oil if needed. *Do not check or fill while running.* Change oil every 2000 operating hours, or more frequently depending on the type of oil and ambient conditions.

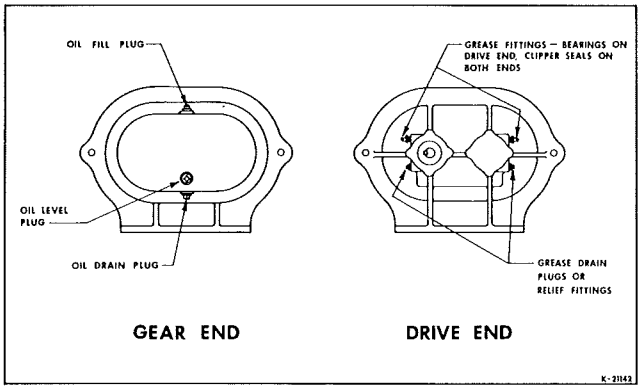


FIGURE 4—LUBRICATION POINTS

Shaft bearings at the drive end of the gas pump are grease lubricated and each bearing housing is equipped with pressure type grease fittings. To service the 2½, 3½, 4 and 5 inch bearings, first remove the grease drain plug that's shown in Figure 4. Removing this plug alleviates the problem of "over-greasing" which can create pressure in the bearing housing and force the impellers into the gear end headplate. (This step isn't required on the 6 and 7 units because they are equipped with pressure type relief fittings in lieu of the drain plugs.) Then using a good quality grease of NLGI Grade 2 in a pressure gun, force new lubricant into each drive end bearing housing until traces of clean grease appears coming out of the drain plug hole or relief fitting, whichever is applicable.

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

After a long shutdown, it is recommended that the grease drain plugs or relief fittings be removed. The old grease must be flushed out with #10 lubricating oil or kerosene, bearing housing drained thoroughly, and bearings refilled with new grease. Be sure grease drain plugs or relief fittings are re-installed.

Grease should be added to the drive end bearings at the initial start-up and 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.

SHAFT SEAL ARRANGEMENT & MAINTENANCE

STANDARD CLIPPER SEALS

Figure 6 shows the standard clipper seal arrangement. A spacer ring, beveled on one side and square on the other side, is installed to form a seat against the stuffing box bottom and a square shoulder for the seals. ing box bottom and a square shoulder for the seals. (4" Gas pumps do not use spacer rings.) A grease ring is installed behind the seal nearest to the stuffing box gland, it provides space for introducing grease necessary to lubricate the seals. The gland clamps the seals in place.

Before starting the pump for the first time, the seals should be greased with silicone grease (Dow Corning #44 med. or equal) through the pressure gun connection in each stuffing box. If this grease reacts with the gas being pumped, a grease of comparable lubrication value and non-reactive with the gas being pumped, should be used. The seals should be greased weekly and before each shut-down. If shut-down occurs weekly, the greasing immediately before shut-down will suffice for the weekly lubrication. *IMPORTANT:* The greasing as outlined above, should at all times be sparing so that excessive grease will not enter the pump or plug up vent passages, piping, etc. Excessive grease will normally appear through glands.

The seals will normally run warm, and may run hot during the initial start up. If they run hot over an extended period of time (more than 24 hours) the cause of overheating should be investigated. The seals should normally have little or no leakage. Should the rate of leakage increase above this normal, with no indication of improvement, the cause should be investigated, before extended operation of the unit takes place.

The gas pump is shipped with the packing gland tightened to a snug fit and should not require additional adjustment. Excessive tightening may ruin the seals or cause leakage.

OPTIONAL GRAPHITE PACKING

Some gas pumps are equipped with graphite impregnated packing as shown in Figure 6 in lieu of the standard clipper seals. This type of packing requires no lubrication, therefore, the stuffing boxes are not equipped with pressure type grease fittings. On the initial start-up, the packing gland nuts should be finger

tight. After starting, tighten the packing gland nuts slowly and uniformly in increments of 1/8 turn until the out leakage of gas is minimized.
When adjusting the packing, check the warmth of the stuffing boxes by hand. If the temperature rises, loosen the packing glands slightly. Overheating may cause the packings to burn and become useless and may also damage the shafts.

Over tightening the packing glands can force the impeller into the headplate and damage the gas pump.

OPERATION

Before operating a gas pump under power for the first time, recheck 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 gas pump chamber.
2. **Be certain** that inlet piping is free of debris. Use of the temporary protective screen at the gas pump as described under INSTALLATION is strongly recommended.
3. **Recheck** gas pump 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 gas pump 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 line. If a valve is in the inlet piping, be sure it is open.
8. Bump gas pump a few revolutions with driver to check that direction of rotation agrees with piping connections shown in Fig. 2, and that both units coast freely to a stop.

After the preceding points are cleared, gas pump 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 gas pump, 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 gas pump run 2 or 3 minutes. Check for noises, and vibrations of 5 mils or greater.
c. Operate gas pump 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 gas pump should now have a final check run of at least one hour under normal operating conditions. After gas pump 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 gas pump 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 gas pump exceeds the limit specified in this manual shut down and investigate conditions in the piping system or in the process to which gas is being supplied.* Refer to the TROUBLE SHOOTING CHECK-LIST for suggestions on various problems that may appear.

The gas pump 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 gas pump is supplying gas to a process system where conditions can vary. At the first opportunity, stop the gas pump 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 gas pump capacity is a little too high for the actual gas requirements, the excess may be by-passed to the inlet as shown in Figure 3. **Never rely on the pressure relief valve as an automatic by-pass.** Such use may cause the discharge pressure to become excessive, and can also result in failure of the valve itself. If gas pump capacity appears to be too low, refer to the TROUBLE SHOOTING CHECK-LIST first. If no help is found there, it may be possible to increase the gas pump speed. Before attempting this change, contact the nearest Sales Office for recommendations. Be prepared to furnish data on actual gas requirements and operating pressure/temperature conditions.

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

- **Gas pump casing and associated piping or accessories may become hot enough to cause major skin burns on contact.**
- **Internal and external rotating parts of the gas pump and driving equipment can produce serious physical**

TROUBLE SHOOTING CHECKLIST

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

injuries. Do not reach into any opening in the gas pump 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 divices.**
- **If gas pump 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 gas pumps, and the open discharge blast from vacuum gas pumps.**
- **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 procedure 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 procedures.**

MAINTENANCE & REPLACEMENTS

A good program of inspection and maintenance servicing, followed consistently, is the most reliable method of minimizing repairs to a gas pump. 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 gas pump must be operated within its specified rating limits** to obtain satisfactory service life.

A newly installed gas pump 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 2000 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 gas pump through a lubricated type coupling, the coupling should be checked and greased each time gas pump 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 gas pump there are no moving contacts between the two impellers, or between the impeller and cylinder or headplates. Wear is then confined to the bearings 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 gas pump. 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 is no longer supported and properly located, extensive general damage to the gas pump casing and gears is likely to occur.

Shaft seals should be considered expendable items, to be replaced whenever leakage becomes excessive, or when the gas pump is disassembled for any reason. Sealing effectiveness can vary considerably from seal to seal, and is also affected to a surprising degree by shaft smoothness and freedom from scratches under the seal lip. Because of these normal variables, minor seal leakage should not be considered as indicating a need for 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 accomodate 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 gas pump 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 gas pump are only a few thousandths of an inch. This makes it possible for impeller interferences or casing rubs to result from shifts in the gas pump mounting, or from changes in piping support. Foreign materials sucked into the gas pump will also cause trouble, which can only be cured by disconnecting the piping and thoroughly cleaning the gas pump interior.

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

A wide range of causes for operating troubles are covered in the TROUBLE SHOOTING CHECK-LIST. 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 before starting work. Unauthorized disassembly within the warranty period may void the warranty.

When a gas pump is taken out of service it will 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 gas pump should be protected immediately. Simplest treatment is to spray or flush the interior with a mixture of light oil and kerosene, or use a rust inhibitor that is compatible with the gas being handled, 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 gas pump openings with vapor barrier paper or tape.

This protection is normally effective for about one year. Before returning gas pump to service, inspect all internal surfaces. If dirt of any kind is found, clean all surfaces thoroughly with a good petroleum solvent. Otherwise, gas pump 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 gas pump is not available. If a gas pump 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 6 and Table 7. Also specify quantities wanted and the gas pump size and serial number from the nameplate.

Repairs on 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 6, 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 undertaking 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 bottom plug (23). Remove gearhouse by taking out all cap screws (18) 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 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. 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.

6. Start a gear on the driving shaft with hub facing away from the headplate. Carefully drive the gear until it is about ¼ in. away from seating against the shaft shoulder.

7. Place second gear on other shaft in same manner. **Match marks on gear teeth should come together when gears are rolled.** This can be checked by counting teeth on one gear and spaces on the other between the match marks and the present meshing point.

8. Remove the impeller blocking feelers. Rotate the impellers to make sure they do not bump, then measure front and back lobe clearances with feelers when impellers are in positions shown in Figure 5. These two clearances should be equal when the impellers are properly "timed" and should be within the theoretical limit given in Table 5.

9. If not equal, add the two clearances and divide by 2 to determine the correct clearance. Add 0.003 in. to the result and wedge feelers of the total amount tightly between the lobes in the closer position (front or back). This can be done by rotating the gears sharply. Return the 0.003 in. strips to the impeller ends or bump both gears so they move about 1/64 in. along the shafts. This will "slip" one or both gears and change the lobe clearances.

10. Free the impeller ends again and recheck front and back clearances. If not equal, repeat step 9 until correct. It is very important that the impeller timing be accurately done. Finally, drive both gears up to their shaft shoulders while continuing to check that the

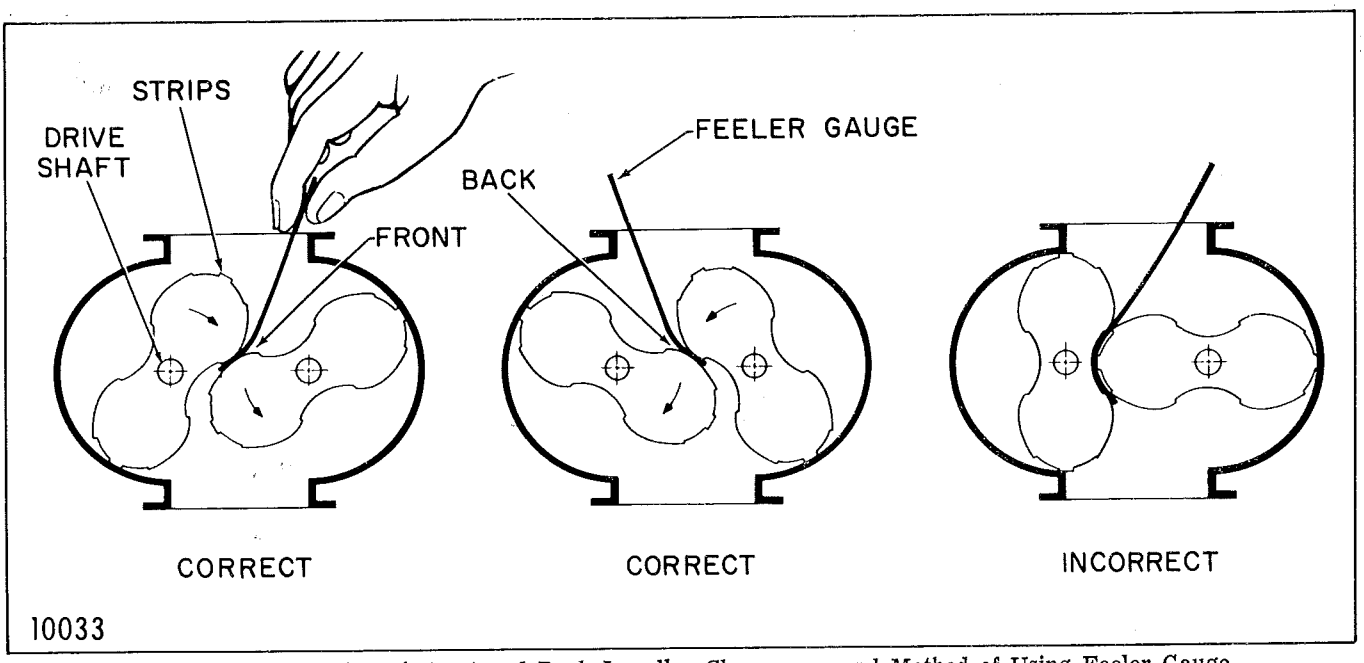


Figure 5 Identification of Front and Back Impeller Clearances, and Method of Using Feeler Gauge

equal clearances are maintained.

11. Wedge the gears to prevent rotation, and drill and ream a taper pin hole at a right angle to the old hole in the shaft. Ream carefully so as not to make the hole larger than necessary, but obtain a clean hole all around for good pin seating. Inspect the reamed hole by holding a light at the small end. The walls should appear bright, with no dull areas and no offsets at the shaft lines. Support the gear hub and drive a new pin firmly into the reamed hole. The large end should not go below the hub surface.

12. Repeat step 11 for the other gear taper pin, first rotating the gears as necessary to permit drilling and reaming. In each case, make sure cuttings do not get into the gear teeth and remain there.

13. Make a final check of front and back clearances, and spin the impellers to make sure there is no dirt in the casing to cause scraping.

14. Check the end clearances between impellers (away from the shafts) and headplates. Bump the ends of the shafts as required to make the two ends of each impeller equal.

B—REPLACING SHAFT BEARINGS, SEALS AND IMPELLERS

Start as in Section A, removing coupling or sheave from the drive shaft. Drain and remove gearhouse, and pull the timing gears. If gears are to be reused, mark them so they may be returned to the same shafts.

1. Remove bearing end cover (9) at the drive end.

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. Loosen the stuffing box glands.

4. 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 evenly, the headplate will be separated from the cylinder. As the headplate comes off the shafts it will bring the bearings and shaft seals with it.

5. 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.

6. 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.

7. Push or tap out the seals and bearings. The seals will be damaged in this operation and must be replaced. Note that the 2-½, 3-½, 4 and 5 inch gas pumps employ self-sealed bearings instead of separate seals and open bearings as on the 6 inch and 7 inch units.

8. Remove the shaft split clipper seals or packing.

9. Clean bearing and seal pockets in both headplates, and remove burrs or rough edges.

10. Install new clipper seals or packing as outlined in Section C (Gas pumps with packing can be assembled either before or after the packing is installed.)

11. On the 6 inch and 7 inch, press four 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.

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

13. Assemble impellers into the cylinder with the drive shaft (longer shaft) in same location as in orig-

inal assembly. Before starting the shafts through the headplate holes, make sure shaft ends have no sharp or rough edges to damage seal lips. Make sure that the shaft shoulders have a generous chamfer and apply a non-reactive grease to the shaft seal area. Rotate the impellers when pushing the shaft thru the seals. Position impellers at 90° to each other in the cylinder, using lobe-and-waist match marks if original impellers are being re-installed.

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

15. 2-½, 3-½, 4 and 5 inch units have single sealed bearings on the gear end and drive end in lieu of separate lip seals and open bearings as on the 6 and 7 units. Care must be taken to insure that the bearings are installed with the seals toward the impellers. Install new bearings at gear end. First place 0.003 in. feeler between impeller ends and headplate. Push bearings onto shafts and press or tap into headplate until approximately 1/8 in. below its machined face. If possible, use a tube with flanged end that will contact both bearing races simultaneously.

Otherwise, work against the inner race and be sure the outer race does not cock as it enters the headplate recess.

16. Install new bearings at drive end. Push bearings onto shafts and press or tap into headplate until approximately 3/8 inch below its machined face.

17.Install gears and time impellers as in Section A.

18. Set the impeller end clearances equal at both ends by tapping on the shaft ends. Install drive end cover (9). Replace drive shaft seal (29) 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.

19. Install the gearhouse after cleaning out the inside.

20. Fill with correct grade of oil as specified in "Lubrication" section.

21. Reinstall coupling or belt sheave.

22. Check axial float of the drive shaft and be sure the impeller is not touching either headplate.

C.—REPLACING SHAFT SPLIT CLIPPER SEALS OR PACKING: SPLIT CLIPPER SEALS:

(For ease of installation, the gas pump should be completely disassembled to replace the seals.)

1. Remove the seals by hooking them out the bearing side.
2. Remove the split grease ring and spacer ring.
3. Thoroughly clean the stuffing box, spacer ring and split grease ring.
4. Insert the spacer ring, with tapered side toward the impellers. This will form a square seat for the seals.
5. Apply a non-reactive silicone grease to the stuffing box bore and seal O.D.
6. Press the first seal into the stuffing box until it seats against the spacer ring. Be sure the seal lip points toward the impellers as shown in Figure 6.
7. Do the same with the second seal. Make sure that the cut joint of each clipped seal is displaced 180° from the joint of the adjacent seal.
8. Install the split grease ring.
9. Install the third seal with the lip pointing toward the bearings as shown in Figure 6.
10. Place the gland squarely against the last seal and tighten the gland to a snug fit. Excessive tightening may ruin the seals or cause leakage.
11. Repeat the above procedure for the remaining stuffing boxes.

PACKING

1. Remove the nuts holding the gland, and move the gland back as far as possible.
2. Remove the old packing by using a flexible packing hook. Thoroughly clean the stuffing box and shaft and be sure that both the shaft and stuffing box are smooth.
3. If precut packing rings are not available, use the chart shown in Table 6 to select the packing size. Follow the packing manufactures recommendations for installation and cutting techniques.

The stuffing boxes are packed with a soft asbestos graphite impregnated packing, at the factory.

4. Wipe rings and shaft with a non-reactive oil. Insert rings one at a time with joints staggered 90° apart. Seat each ring individually with the gland and turn shaft occasionally to assist seating. Unless bottom rings are each properly seated, the gland will not be able to tighten the packing set, as it will leave the front rings (gland end) too tight in the stuffing box.
5. Tighten the packing gland nuts finger tight, for the initial starting.
6. After starting the gas pump, tighten the packing gland nuts slowly and uniformly in increments of 1/8 turn until the out leakage of gas is minimized.
7. Check the warmth of the stuffing boxes by hand. If the temperature rises, loosen the packing gland nuts.

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 5 are the ranges of impeller clear-

ances used in factory assembly of normal XA gas pumps. 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 5—NORMAL XA GAS PUMP INTERNAL CLEARANCES

XA	IMPELLER ENDS		CYLINDER	IMPELLER
SIZE	TOTAL TIPS	TOTAL HUBS*	TOP, BOTTOM CENTER	FRONTS & BACKS
22	.004-.008	.001-.005	.004-.0055	.0055-.0075
24	.004-.008	.001-.005	.004-.0055	.0055-.0075
315	.004-.008	.001-.005	.0045-.0065	.0085-.0105
33	.004-.008	.001-.005	.0045-.0065	.0085-.0105
36	.004-.008	.001-.005	.0045-.0065	.0085-.0105
42	.0045-.0085	.001=.005	.005-.007	.0095-.0115
44	.0045-.0085	.001-.005	.005-.007	.0095-.0115
47	.0045-.0085	.001-.005	.005-.007	.0095-.0115
53	.0045-.0085	.001-.005	.0055-.0075	.0115-.0135
55	.0045-.0085	.001-.005	.0055-.0075	.0115-.0135
59	.0045-.0085	.001-.005	.0055-.0075	.0115-.0135
65	.008-.012	.004-.008	.0065-.0085	.013-.015
67	.008-.012	.004-.008	.0065-.0085	.013-.015
610	.008-.012	.004-.008	.0065-.0085	.013-.015
615	.008-.012	.004-.008	.0065-.0085	.013-.015
76	.009-.013	.005-.009	.0075-.0095	.015-.017
710	.009-.013	.005-.009	.0075-.0095	.015-.017
717	.009-.013	.005-.009	.0075-.0095	.015-.017

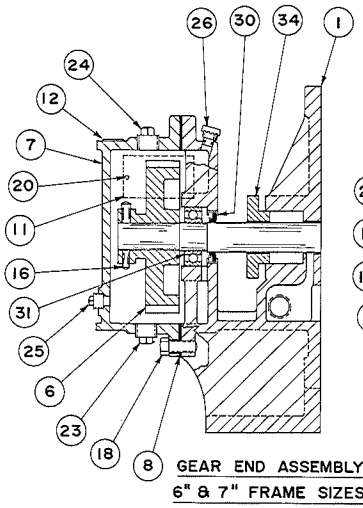
*SEE FIGURE 6 – Impeller hub is a raised area around the shaft on each end varying from 1/4"–1/2" width, depending on blower size.

TABLE 6—STUFFING BOX PACKING (All Dimensions in Inches)

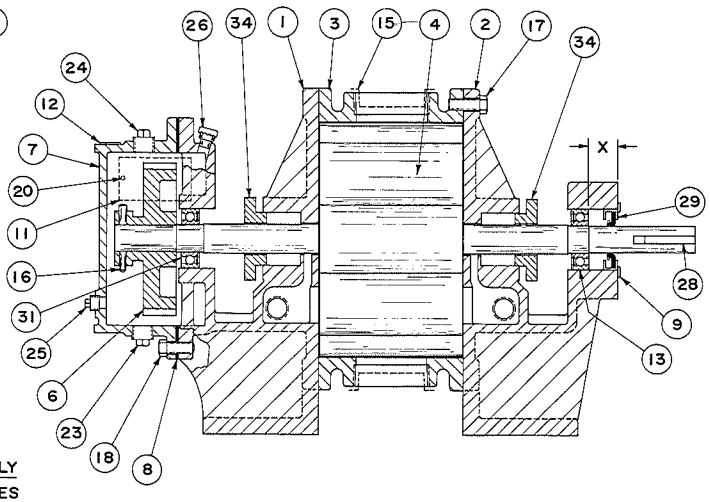
PUMP SIZE GEAR DIA.	SQUARE CROSS-SECTION OF PACKING	TOTAL LENGTH FOR ONE PUMP	STUFFING BOX DIA.	SHAFT DIA.	NO. OF RINGS PER STUFFING BOX
2½	¼	56	1 3/32	19/32	4
3½	¼	61	1 3/16	11/16	4
4	¼	68	1 5/16	13/16	4
5	¼	94	1 ½	1	5
6	5/16	126	2	1 3/8	5
7	3/8	186	2 21/64	1 37/64	5

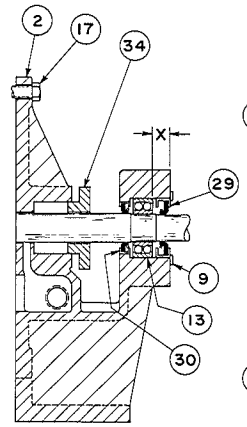
TABLE 7—PARTS IDENTIFICATION LIST FOR FIGURE—6

ITEM NO.	QT'Y USED	IDENTIFICATION	ITEM NO.	QT'Y USED	IDENTIFICATION
1.	1	Gear End Headplate	24.	1	Oil Filler Plug
2.	1	Drive End Headplate	25.	1	Oil Level Plug
3.	1	Cylinder	26.	1	Vent Cap
4.	1	Drive Shaft & Impeller Assembly			
5.	1	Driven Shaft & Impeller Assembly	28.	1	Key
6.	2	Gear	29.	1	End Cover Seal
7.	1	Gearhouse	30.	4	Headplate Seal (6" & 7" Only)
8.	1	Gasket	31.	2	Bearing (Gear End)
9.	1	Blind Cover			
			33.	Varies	Clipper Seal
11.	1	Nameplate			(Or Optional Graphite Packing)
12.	1	Lube Label	34.	4	Gland (Stuffing Box)
13.	2	Bearing (Drive End)	35.	4	Stud (Drive End)
14.	4	Dowel Pin	36.	4	Stud (Gear End)
15.	2	Tin Plug	37.	8	Nut
16.	2	Taper Pin			
17.	Varies	Capscrew (Head To Cylinder)	39.	8	Pipe Plug
18.	Varies	Capscrew (Gearhouse To Head)	40.	4	Grease Fitting
					(Pipe Plug On Units With Packing)
20.	2	Drive Screw	41.	4	Flat Washer (4" With Packing Only)
21.	2	Grease Fitting (Drive End Bearings)	42.	4	Pipe Plug (4" & Larger Only)
22.	2	Grease Drain Plug	43.	4	Grease Ring (Not Used With Packing)
		(6" & 7" Use Pressure Relief Fitting)	44.	4	Spacer Ring
23.	1	Oil Drain Plug			(All Clipper Seal Units, Except 4")

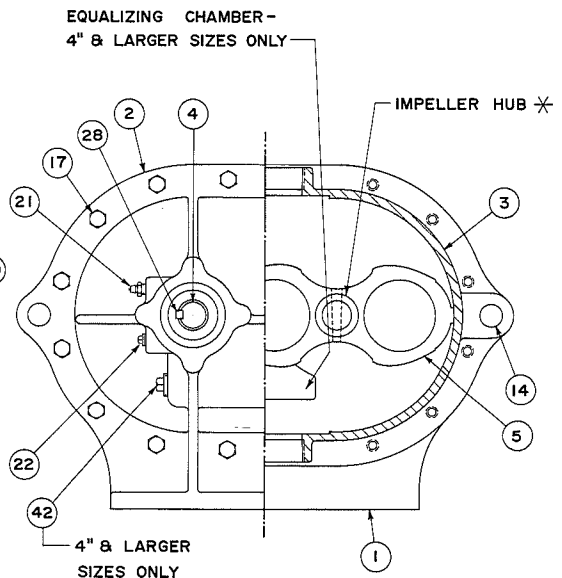


GEAR END ASSEMBLY
6" & 7" FRAME SIZES





DRIVE END ASSEMBLY
6" & 7" FRAME SIZES



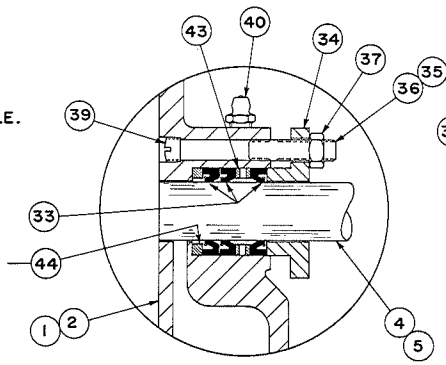
4" & LARGER
SIZES ONLY

4" SIZE ONLY

ASSEMBLY NOTES

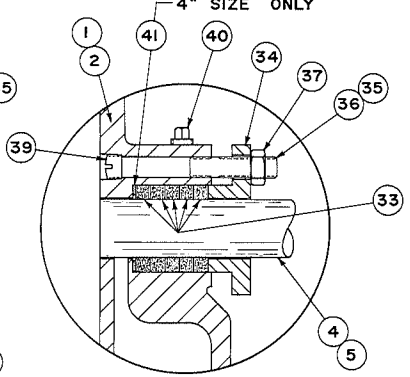
1. ALL SIZES - GEAR HUBS TO BE INSTALLED FLUSH WITH END OF SHAFT.
2. ALL SIZES - DRIVE END BEARINGS TO BE INSTALLED APPROX. "X" DEEP IN HEADPLATE BORE - SEE TABLE.
3. ALL SIZES - GEAR END BEARINGS TO BE INSTALLED APPROX. 1/8" DEEP IN HEADPLATE BORE.
4. 2 1/2" THRU 5" SIZES - BEARINGS TO BE INSTALLED WITH SEALS TOWARD IMPELLERS.
5. ALL SIZES - DRIVE SHAFT SEAL TO BE INSTALLED FLUSH WITH HEADPLATE FACE.

SIZE	"X"
2 1/2"	5/8"
3 1/2"	1/2"
4"	1/2"
5"	5/8"
6"	11/16"
7"	11/16"



NOT USED
WITH 4" SIZE

TYPICAL HEADPLATE STUFFING BOX
- UNITS WITH CLIPPER SEALS -



TYPICAL HEADPLATE STUFFING BOX
- UNITS WITH GRAPHITE PACKING -

851-178-023

DISTRIBUTORS

REPLACEMENT UNITS AND REPAIRS SMALL BLOWERS AND VACUUM PUMPS

ALABAMA

BIRMINGHAM
Compressor & Pump Shop, Inc.
P.O. Box 550
Birmingham (Bessemer), Alabama 35202
(205) 424-1990

ARIZONA

PHOENIX
Supplies for Industry, Inc.
Pumps & Compressors Sls. & Svc.
1901 E. 5th St.
Tempe, Arizona 85281
(602) 968-2404

TUCSON
Supplies for Industry, Inc.
Pumps & Compressors Sls. & Svc.
960 E. 17th St.
Tucson, Arizona 85726
(602) 623-9474

ARKANSAS

LITTLE ROCK
Jack Tyler Engineering Co.
6112 Patterson Ave.
Little Rock, Arkansas 72209
(501) 562-2296

CALIFORNIA

EUREKA
Rogers Machinery., Inc.
3428 Jacobs Ave.
Eureka, California 95501
(707) 443-6389

LOS ANGELES
American Compressor Co.
12078 E. Florence Ave.
Santa Fe Springs, California 90670
(213) 944-6188

Compressor Service Co.
11901 S. Alameda St.
Los Angeles, California 90059
(213) 567-2376

SAN FRANCISCO
King-Knight Co.
6202 Cristie Ave.
Emeryville, California 94608
(415) 658-9400

SAN DIEGO
American Compressor Co.
7768 Clairmont Mesa Blvd.
San Diego, California 92111
(714) 278-9980

Compressor Service Co.
5901 Mission Gorge Road
San Diego, California 92120
(714) 281-7767

COLORADO

DENVER
Ainsworth Air Equipment Co.
1 South Kalamath
Denver, Colorado 80223
(303) 825-5138

FLORIDA

LAKELAND
Barney's Pumps, Inc.
3907 Highway 98 South
Lakeland, Florida 33801
(813) 686-8195

GEORGIA

ATLANTA
Pye-Barker Supply Co.
P.O. Drawer M
121 Royal Drive
Forest Park, Georgia 30050
(404) 363-6000

ILLINOIS

CHICAGO
Cochrane Compressor Svc. & Supply Co.
1220 West Randolph St.
Chicago, Illinois 60607
(312) 738-1276

Compressor Engineering Co.
4246 West 47th St.
Chicago, Illinois 60632
(312) 254-3100

INDIANA

FT. WAYNE
Wayne Vaughn Equipment Co., Inc.
716 E. Wayne St.
Fort Wayne, Indiana 46802
(219) 742-6433

INDIANAPOLIS
Robert E. Bragg Assoc., Inc.
6834 Hawthorne Park Drive
Indianapolis, Indiana 46220
(317) 849-5531

TERRE HAUTE
General Equipment Co. (Industrial Only)
1308 Wabash Ave.
Terre Haute, Indiana 47801
(812) 235-8700

KENTUCKY

LOUISVILLE
Wm. J. Showalter & Sons. Inc.
1420 Jackson St.
Louisville, Ky. 40217
(502) 635-6318

LOUISIANA

NEW ORLEANS
Menge Pump & Machinery, Inc.
P.O. Box 215
Metairie, Louisiana 70002
(504) 888-8830

MARYLAND

BALTIMORE
Tate Engineering, Inc.
600 W. West St.
Baltimore, Maryland 21230
(301) 539-0787

MASSACHUSETTS

BOSTON
PEECO, Inc.
79 Prospect St.
Somerville, Mass. 02143
(617) 666-4444

MICHIGAN

DETROIT
Detroit Air Compressor & Pump Co.
3205 Bermuda
Ferndale, Michigan 48220
(313) 564-6429
(313) 548-5222

GRAND RAPIDS
Air Power Co.
4581 Patterson Rd., S.E.
Grand Rapids, Michigan 49508

MINNESOTA

MINNEAPOLIS
John Henry Foster Co.
3748 Minnehaha Ave.
Minneapolis, Minnesota 55406
(612) 721-1666

MISSOURI

KANSAS CITY
Kansas City Pneumatic, Inc.
1622 Wyandotte
Kansas City, Missouri 64108
(816) 421-3144

ST. LOUIS
St. Louis Compressor Service Co.
2017 Locust St.
St. Louis, Missouri 63103
(314) 241-8868

NEW JERSEY

HACKENSACK
Argo Pneumatic, Inc.
162 Lodi Street
Hackensack, New Jersey 07601
(201) 343-7300

NEW YORK

BUFFALO
Fargo Equipment Co.
487 Seneca St.
Buffalo, New York 14204

LONG ISLAND
Argo Compressor Service Corp.
19-35 Hazen St.
Jackson Heights, L.I., New York 11370
(212) 726-7800

Hayes Machine Co.
1103 - 43rd Road
Long Island City, New York 11101
(212) 784-7965

ROCHESTER
Siewert Equipment Co., Inc.
175 Akron St.
Rochester, New York 14609
(716) 482-9640

OHIO

CINCINNATI
Industrial Electric Motors, Inc.
10520 Taconic Terrace
Cincinnati, Ohio 45215
(513) 771-0680

CLEVELAND
Pumps, Inc.
7777 Exchange St.
Cleveland, Ohio 44125
(216) 524-9140

DAYTON
Industrial Electric Motors, Inc.
5131 Webster St.
Dayton, Ohio 45414
(513) 278-7355

OKLAHOMA

TULSA
Harley Industries
6845 E. 41st St.
Tulsa, Oklahoma 74145
(918) 627-9220

OREGON

PORTLAND
Rogers Machinery Co., Inc.
14600 S.W. 72nd Ave.
Portland, Oregon 97223
(503) 639-6151

PENNSYLVANIA

ALLENTOWN
Crowder Company
1818 Voltee
Allentown, Pennsylvania 18105
(717) 791-1551

IRWIN
Airtek, Inc.
76 Clair North Huntington
Irwin, Pennsylvania 15642
(412) 863-1350

PHILADELPHIA
R & M Associates, Inc.
340 Crooked Lane
King of Prussia, Pennsylvania 19406
(215) 279-6120
(215) 828-7500

PITTSBURGH
Harris Pump & Supply Co.
5800 Grand Ave.
Pittsburgh, Pennsylvania 15225
(412) 771-7100

TENNESSEE

MEMPHIS
Air Compressor Sls. & Svc. of TE, Inc.
20 West Huling Ave.
Memphis, Tennessee 38103

Automation Equipment Co.
4409 Princeton Drive
Memphis, Tennessee 38117
(901) 683-9022

NASHVILLE
Automation Equipment Co.
1205 Church St.
Nashville, Tennessee 37202
(615) 254-7551

Compressor & Pump Shop, Inc.
916 3rd Ave. S.
Nashville, Tennessee 37210
(615) 254-1909

TEXAS

HOUSTON
McKenzie Equipment Co.
9260 Bryant St.
Houston, Texas 77034
(713) 946-1413

ODESSA
Harley Industries
P.O. Box 1549
Odessa, Texas 79760
(915) 337-8675

UTAH

SALT LAKE CITY
Pace Industries
P.O. Box 2605
Salt Lake City, Utah 84110

VIRGINIA

RICHMOND
Tate Engineering, Inc.
2512 Waco St.
Richmond, Virginia 23229
(804) 288-6023

WASHINGTON

SEATTLE
Rogers Machinery Co., Inc.
7800 Fifth Ave., South
Seattle, Washington 98108
(206) 763-2530

WEST VIRGINIA

LOGAN
Guyan Machinery Co.
P.O. Box 150
Logan, West Virginia 25601
(304) 752-5640

WHEELING
Scott Fluid Power Co.
3825 Jacob St.
Wheeling, West Virginia 26003
(304) 232-6006

WISCONSIN

ELM GROVE
Air Engineering Co.
910 Elm Grove Road
Elm Grove, Wisconsin 53122
(414) 786-4363

GREEN BAY
Cochrane Compressor Co., Inc.
733 Potts Ave.
Green Bay, Wisconsin 54303
(414) 499-6216

MILWAUKEE
Cochrane Compressor Co., Inc.
1500 West National Ave.
Milwaukee, Wisconsin
(414) 383-1014

CANADA

CALGARY
PAMCO, Ltd.
82 Ave. & 31 St. S.E.
Calgary, Alberta, Canada
(403) 279-5561

EDMONTON
PAMCO, Ltd.
8235 Wagner Road
Edmonton, Alberta, Canada
(403) 465-5371

HALIFAX
A. G. Dunbar
2745 Dutch Village Road
Halifax, Nova Scotia, Canada
(902) 455-5421

MONTREAL
Scott Industrial Products
2700 Paulus St.
Montreal, 386, P.Q., Canada
(514) 336-5661

TORONTO
Canadian Air Compressor Ltd.
84 Queen Elizabeth Blvd.
Toronto 18, Ontario, Canada
(514) 251-1737

AUSTRALIA

ALEXANDRIA, N.S.W.
Godfrey Engrg. (Australia) Pty. Ltd.
19-21 Mandible St.
Alexandria, N.S.W. 2015

NIDDRIE, VICTORIA
Godfrey, Engrg. (Australia) Pty. Ltd.
P.O. Box 84
Niddrie, Victoria 3042
Australia

Printed in U.S.A.

INSTRUCTIONS FOR THE MAINTENANCE & INSTALLATION OF THE STANDARD SPLIT CLIPPER SEALS ON XA GAS PUMPS

General:

These instructions are intended as a supplement to the paragraph titled "Stuffing Box Packing" in the bulletin for the XA gas pumps. Any reference made to the stuffing box in the above bulletin should be disregarded, and the following instructions should be used.

Reference:

Figure 1 and 2 show the sectional assemblies of Johns-Manville split-clipper seals for 2-1/2" thru 7" G.D. XA gas pumps. The seal material is Buna-N unless otherwise specified.

Seal Arrangement & Maintenance:

Figure 1 and Figure 2 show clipper seal arrangements for pressure and vacuum services respectively.* A lantern ring, beveled on one side and square on the other side, is installed to form a seat against the stuffing box bottom and a square shoulder for the seals.** A grease ring is installed behind the seal nearest to the stuffing box gland, it provides space for introducing grease necessary to lubricate the seals. The gland clamps the seals in place.

Before starting the pump for the first time, the seals should be greased with graphite grease through the grease connection in each stuffing box. If this grease reacts with the gas being pumped, a grease of comparable lubrication value and non-reactive with the gas being pumped, should be used. The seals should be greased weekly and before each shut-down. If shut-down occurs weekly, the greasing immediately before shut-down will suffice for the weekly lubrication. IMPORTANT The greasing as outlined above, should at all times be sparing so that excessive grease will not enter the pump or plug up vent passages, piping, etc. Excessive grease will normally appear through glands.

The seals will normally run warm, and may run hot during the initial start up. If they run hot over an extended period of time (more than 24 hours), the cause of overheating should be investigated. The seals should normally have little or no leakage. Should the rate of leakage increase above this normal, with no indication of improvement, the cause should be investigated, before extended operation of the unit takes place.

* Clipper seals are installed at the factory as per Figure 1. This arrangement is for pressure service only. For vacuum service the seals in all 4 glands must be removed and reinstalled as per Figure 2.

** 4" XA Gas Pumps do not use lantern rings.

Seal Removal:

1. Remove the nuts holding the gland, and move the gland back as far as possible.

2. Remove the seals and grease ring on the 2-1/2" and 3-1/2" gear diameter XA gas pumps by forcing air through the pump inlet opening while the discharge opening is blanked off. For a 4", 5", 6", and 7" gear diameter pump, force air through one of the headplate clean out holes under the stuffing box. If the seals do not come out, they will have to be removed by hooking them out, which will probably damage the seals.

3. The grease ring is split and may be removed from the shaft by separating the two halves.

4. The seals may be removed from the shaft by rolling the retaining spring from the seal, then by spreading the seal at its split until it will clear the shaft. The springs may then be removed by unhooking the ends.

5. All parts should be cleaned.

After the cause of the failure is determined, new seals, or undamaged seals should be installed individually by the following method.

Seal Installation:

1. If the lantern ring was removed, place against the stuffing box back shoulder to form a seat for the seals.

2. Prior to installing the seals, apply lubricant to shaft and stuffing box bore to ease the insertion of the seals. The space between the seals, and above the seal lip should be filled with grease.

3. Hook the detachable garter spring around the shaft.

4. Spread the seal apart and slide it over the shaft. Make sure the lip side of the seal is oriented as shown in Figure 1 and 2.

5. Take two welding rods that have been beaten into flat paddles with curved ends. Pick up the spring with the homemade paddles, taking care that the hook and eye are not in line with the cut ends. Then, tuck the spring in the carrier groove, positioning it with one paddle while sliding the other around the groove.

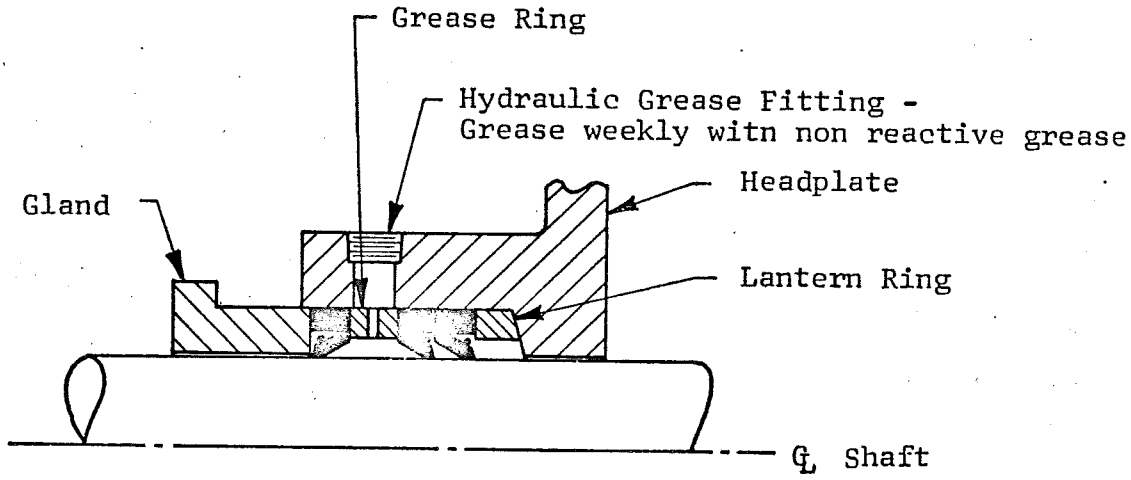
6. Push the seal into the stuffing box until it seats against the lantern ring.

7. Do the same with the second seal. Make sure that the cut joint of each clipper seal is displaced 180° from the joint of the adjacent seal.

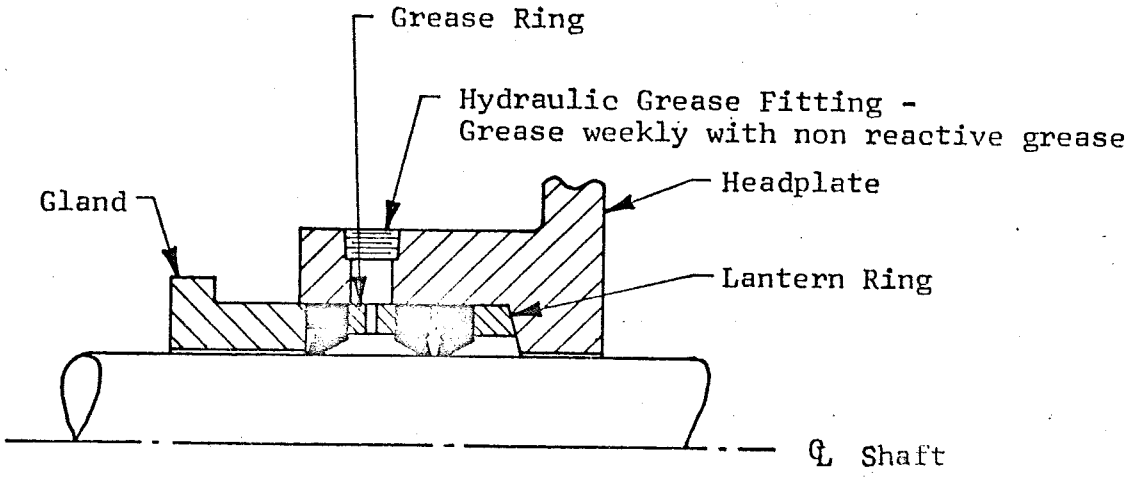
8. Now install the split grease ring and then repeat the same with the third seal.

9. Finally, place the gland squarely against the last seal and tighten up the gland to a snug fit. Excessive tightening may ruin the seals or cause leakage.

10. Repeat the above for the remaining stuffing boxes. Follow the lubrication instructions as outlined under "Seal Arrangement and Maintenance".



SEAL ARRARGEMENT FOR PRESSURE SERVICE
FIG. #1



SEAL ARRANGEMENT FOR VACUUM SERVICE
FIG. #2